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Electronic Design®

International Edition

VOL 28 NO. 8

FOR ENGINEERS AND ENGINEERING MANAGERS — WORLDWIDE

APRIL 12, 1980

Low-power NMOS PCM filter keeps the messages moving

Special Report: Building data-comm systems with multichip modules and boards

Controller chip handles up to eight protocols

Shared codecs or codec-per-line?

Switch from copper to fiber optics in modems

If you thought Panasonic only supplied 'lytics for TV...

FOR INDUSTRIAL APPLICATIONS
Z SERIES (Aluminum)
From 0.1μF to 2200μF and from 6.3 through 50 VDC. Axial or radial leads. Temp. range: - 40°C to +85°C. Standard tolerance: ±20% (±10% available).

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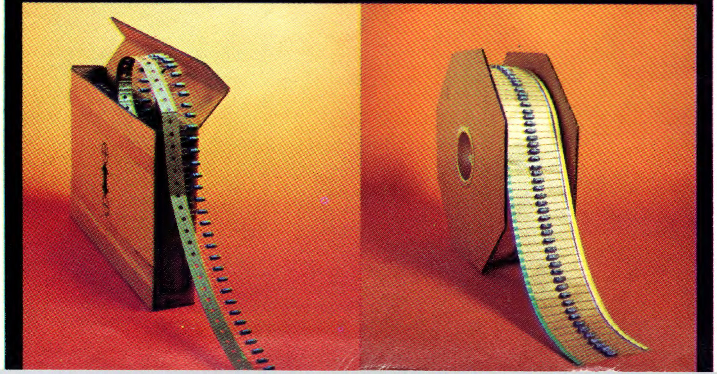
A choice of packaging, too.

Panasonic offers you a wide line of aluminum and tantalum electrolytic capacitors, plus the flexibility of bulk, reel or tape packaging for axial and radial lead units, and lead forming or crimping for both axial and radial units. And they can be ordered from your local Panasonic distributor or our Secaucus headquarters. Panasonic Electronic Components, One Panasonic Way, Secaucus, NJ 07094. (201) 348-7270.



Panasonic®
just slightly ahead of our time

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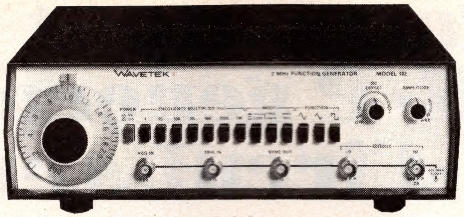

Model 182 $295

But first, lay down that soldering iron and consider the following:

For just $295,* the Model 182 gives you sine, square and triangle waveforms, plus trigger and gate functions. Imagine getting tone bursts and pulse bursts out of an under-$300 instrument!

What's more, the Model 182 can be used as a sweeper. The sweep range (up to 1,000:1 or three decades) is controlled by an external voltage applied to the instrument.

For frequency range, you get 0.002Hz to 2MHz, which is plenty broad for most applications.

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FOR LITERATURE CIRCLE NUMBER 2

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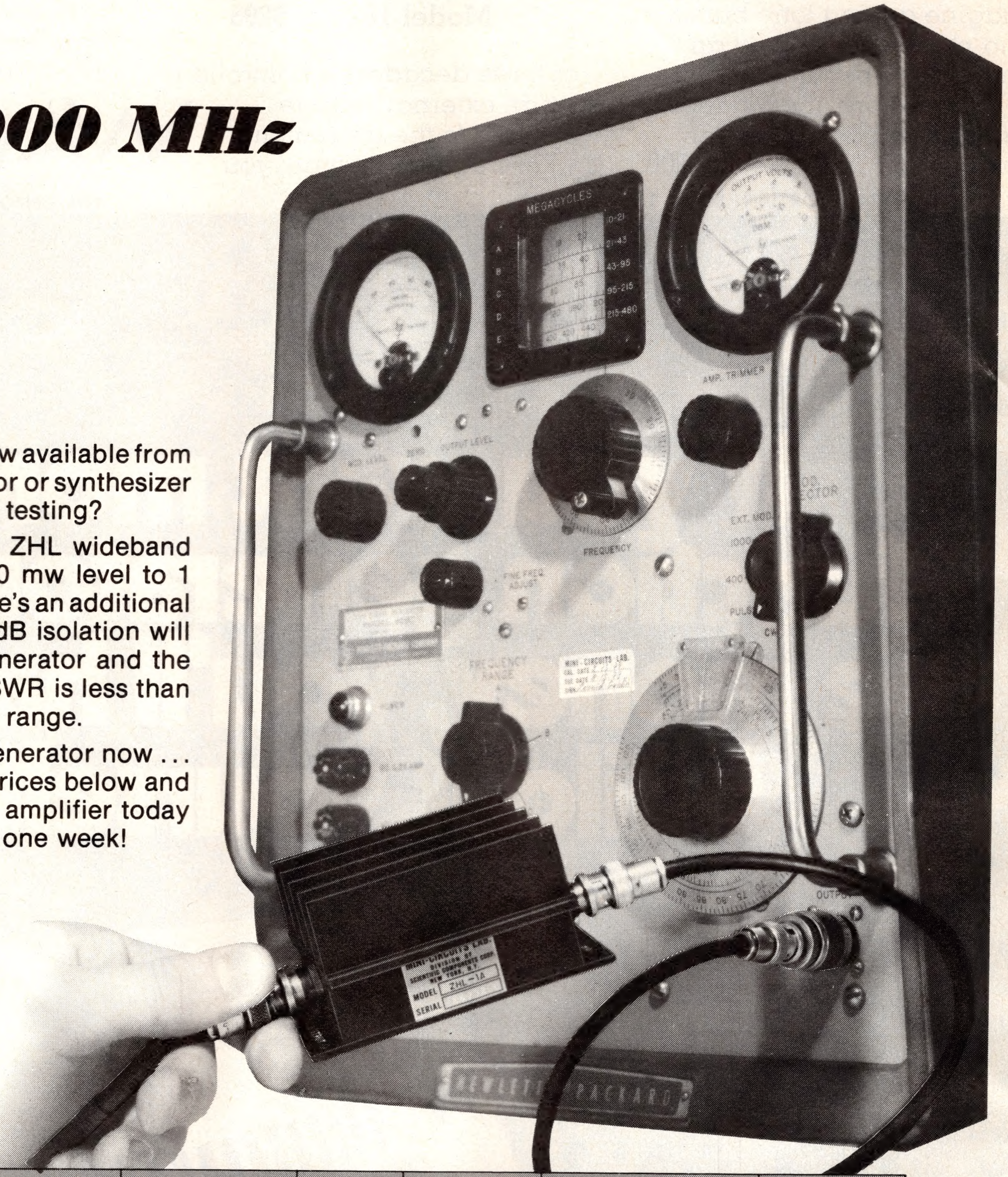
0.05 - 1000 MHz

from $199



Need more than the 10 mw available from your signal/sweep generator or synthesizer for system and subsystem testing?

Just add a MiniCircuits' ZHL wideband amplifier and boost the 10 mw level to 1 watt or +30 dBm. Also, there's an additional benefit ... as much as 40 dB isolation will be added between the generator and the system under test. And VSWR is less than 2:1 over the full frequency range.

Upgrade your present generator now ... check the specs and low prices below and order your ZHL wideband amplifier today ... and we will ship within one week!

MODEL NO.	FREQ. MHz	GAIN dB	GAIN FLATNESS dB	MAXIMUM POWER OUTPUT dBm 1-dB COMPRESSION	NOISE FIGURE dB	INTERCEPT POINT 3RD ORDER dBm	DC POWER		PRICE	
							VOLTAGE	CURRENT	$ EA.	QTY.
ZHL-1A	2-500	16 Min.	±1.0 Max.	+28 Min.	11 Typ.	+38 Typ.	+24V	0.6A	199.00	(1-9)
ZHL-2	10-1000	16 Min.	±1.0 Max.	+29 Min.	18 Typ.	+38 Typ.	+24V	0.6A	349.00	(1-9)
ZHL-3A	0.4-150	24 Min.	±1.0 Max.	+29.5 Min.	11 Typ.	+38 Typ.	+24V	0.6A	199.00	(1-9)
ZHL-2-8	10-1000	27 Min.	±1.0 Max.	+29 Min.	10 Typ.	+38 Typ.	+24V	0.65A	449.00	(1-9)
ZHL-32A	0.05-130	25 Min.	±1.0 Max.	+27 Min.	10 Typ	+33 Typ	+24V	0.6A	199.00	(1-9)

Total safe input power +20 dBm, operating temperature 0° C to +60° C, storage temperature −55° C to +100° C, 50 ohm impedance, input and output VSWR 2:1 max. For detailed specs and curves, refer to 1979/80 MicroWaves Product Data Directory, p. 364-365 or EEM p. 2970-2971.

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Electronic Design

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Low-cost hard disk computers are here and field proven

11 megabytes of hard disk and 64 kilobytes of fast RAM in a Z80A computer for under $10K. Two floppy drives, too. Naturally, it's from Cromemco.

It's a reality. In Cromemco's new Model Z-2H you get all of the above and even more. With Cromemco you get it all.

In this new Model Z-2H you get not only a large-storage Winchester hard disk drive but also two floppy disk drives. In the hard disk drive you get unprecedented storage capacity at this price—11 megabytes unformatted.

You get speed—both in the 4 MHz Z80A microprocessor and in the fast 64K RAM which has a chip access time of only 150 nanoseconds. You get speed in the computer minimum instruction execution time of 1 microsecond. You get speed in the hard disk transfer rate of 5.6 megabits/sec.

EXPANDABILITY

You get expandability, too. The high-speed RAM can be expanded to 512 kilobytes if you wish.

And the computer has a full 12-slot card cage you can use for additional RAM and interface cards.

BROADEST SOFTWARE SUPPORT

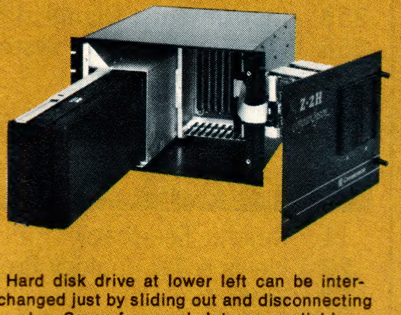
With the Z-2H you also get the broadest software support in the microcomputer field. Software Cromemco is known for. Software like this:

- **Extended BASIC**
- **FORTRAN IV**
- **RATFOR (RATional FORtran)**
- **COBOL**
- **Z80 Macro Assembler**
- **Word Processing System**
- **Data Base Management**

with more coming all the time.

SMALL, RUGGED, RELIABLE

With all its features the new Z-2H, including its hard disk drive, is still housed in just one compact cabinet.



Hard disk drive at lower left can be interchanged just by sliding out and disconnecting plug. Seven free card slots are available. Z-2H includes printer interface card.

Included in that cabinet, too, is Cromemco ruggedness and reliability. Cromemco is time-proved. Our equipment is a survey winner for reliability. Of course, there's Cromemco's all-metal cabinet. Rugged, solid. And, there's the heavy-duty power supply (30A @ 8V, 15A @ +18 V, and 15A @ −18V) for circuitry you'll sooner or later want to plug into those free card slots.

SEE IT NOW

Last summer we told you this new Z-2H would be a smash. And it is. So see it at your dealer's now. Have him put you in touch with a user—there are lots of them because Cromemco has been delivering for months. See for yourself how pleased our users are.

PRESENT CROMEMCO USERS

We've kept you in mind, too. Ask about the new Model HDD Disk Drive which can combine with your present Cromemco computer to give you up to 22 megabytes of disk storage.

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Tomorrow's computers today

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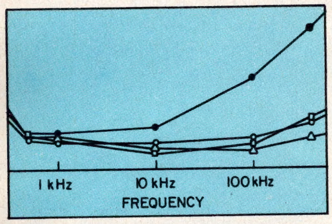
Contents Spotlight



Components Conference centers on fiber optics, passives

The annual Electronic Components Conference, set for late April in San Francisco, will survey the latest in several component technologies: fiber-optic receivers that operate at long wavelengths with vastly improved sensitivity; hermetically sealed laser diodes that will offer lifetimes approaching 40 years; tantalum thin-film capacitors deposited on silicon and other smooth-surface substrates that are directly compatible with high-speed semiconductor logic chips; and polymeric thick-film resistors that will dramatically lower costs and firing temperatures and allow designers to use ultralow-cost substrates, such as plastics and paper.

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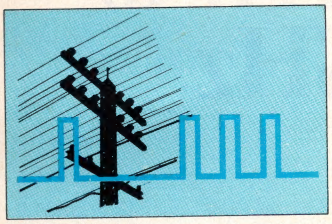

Special Report: Data communications has the right equipment

End-user equipment incorporates more data-comm functions because end-users demand them and OEM designers deliver. This Special Report details the techniques for tying equipment with communications capabilities into working, efficient data-comm systems and networks. It lists the sources for such systems and, in six technical articles, highlights a protocol-controlled LSI, the best performing PCM filter chip, fiber cable for short-haul data links and the shared-channel approach to PCM-codec-system design. Finally, the report shows how to design fiber-optic telecomm systems (the first of a five-part series) and how μP-based array processors should be organized and applied to communications processing.

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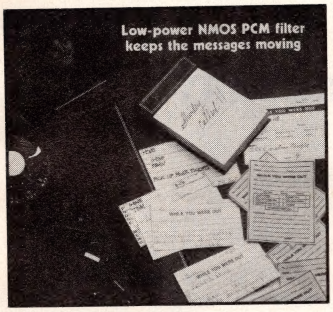

Filter chips simplify and improve PCM

PCM codecs need filtering to conform to Bell-system specs and, when used outside the system, to reduce noise, prevent aliasing and make voice-grade signals conform to line characteristics. Monolithic chips for these filters are the second step in the chain to all-LSI PCM-channel electronics. One LSI filter chip described can slash the per-channel power requirement for PCM systems. Lower power brings such benefits as increased reliability, lower-cost chips, smaller power supplies—and even smaller buildings for housing telephone offices and related functions.

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Synchronous-protocol chip relieves CPU of a big load

Synchronous protocols are the most difficult to handle, because so much intelligence must be brought to bear in implementing them. However, these sets of data-comm rules do handle high-speed data efficiently and thus are becoming progressively important in data-comm-systems design. Much of the overhead in managing these protocols used to be required of the system CPU, but protocol-control chips have been developed to offload the CPU. One of the most efficient of these chips is described in this article, along with details of how to get it working in data-comm applications.

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HP: EXPERIENCE IN MICROWAVE TECHNOLOGY

The HP 8620 Sweeps the Spectrum-

10 MHz to 22 GHz.

A versatile mainframe.

With the 8620C Mainframe, you get the sweep modes and markers you need for both wide and narrow band measurements: a full band sweep with 3 markers, a marker sweep at the touch of a button and a △F sweep that can be as wide as 100% of band. Plus precise frequency setability with the convenient CW vernier and △F "expand" controls; you can set a 1 MHz △F Sweep even at 18 GHz. 8620C Mainframe, $2850.

Wide RF coverage –and high power.

Choose from ultra wideband RF plug-ins—10 MHz to 2.4 GHz with the HP 86222, 2 to 18.6 GHz (optional to 22 GHz) with the HP 86290B—or from octave and double-octave plug-ins, several of which offer 40 mW or more output power. These RF units also provide the excellent frequency accuracy, linearity, and spectral purity that make them ideal sources for general purpose bench and field test applications. They're especially useful in swept frequency test systems such as the HP 8410 and 8755 Network Analysis Systems.

Popular plug-ins include:

Model No.	Freq. Range	Output Power	Price
86222A/B	10 MHz-2.4 GHz	20 mW	$4100/4800
86235A	1.7-4.3 GHz	40 mW	$3500
86240A	2.0-8.4 GHz	40 mW	$4150
86240C	3.6-8.6 GHz	40 mW	$4950
86245A	5.9-12.4 GHz	50 mW	$4600
86260A	12.4-18 GHz	10 mW	$3950
86290A	2-18 GHz	5 mW	$14,250
86290B	2-18.6 GHz	10 mW	$16,250
86290B opt. H08	2-22 GHz	2 mW	$19,250

45007A

HP-IB programmability option adds value.

DESIGNED FOR HP-IB SYSTEMS

HP-IB: Not just IEEE-488, but the hardware, documentation and support that delivers the shortest path to a measurement system.

When you add the HP-IB option ($950) to the 8620C Mainframe, you can program up to 10,000 frequency points per band on up to 4 bands with a variety of sweep modes. With the precision 86222 or 86290 RF units installed in the 8620C, excellent repeatability is achieved thanks to the exceptional frequency accuracy and linearity of these plug-ins.

A real advantage of HP-IB is you get not only the bus architecture you need, but the documentation support that can help you get your system up and running in weeks, instead of months.

A prime example is the scores of HP-IB automatic microwave network analyzer systems now in use. Major elements of these systems are the 8620C/86290B Sweeper, HP 8410 Network Analyzer, and HP 9825A Desktop Computer. Systems like this are fully described in HP Application Notes 221 and 187 Series. You can get copies of these plus information on the 8620C from your local HP sales office, or write Hewlett-Packard, 1507 Page Mill Rd., Palo Alto, CA 94304.

Domestic U.S. prices only.

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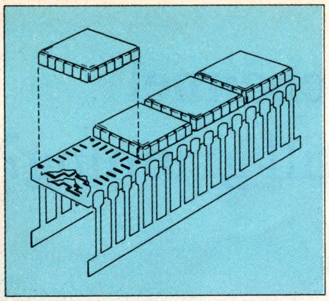

Shared-channel codecs—better performance than per-channel
Shared-channel codecs provide telecomm-system and equipment designers with another method of mating the ubiquitous analog local loop to long-haul PCM transmission highways. Not only can the shared-channel approach save money, it can provide wideband performance that would at best be cumbersome and costly with per-channel codecs. This article shows how and when to use the shared-channel approach.

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Fiber-optic modems—only as good as their links
Fiber-optic modems can be inserted into short-haul links without reprogramming the system controls or changing the RS-232C interface. Then the designer must select the proper fiber cable for the system to perform as required and still be cost-effective. This article zeroes in on what to consider when comparing one fiber cable with another. The results could be eye-opening.

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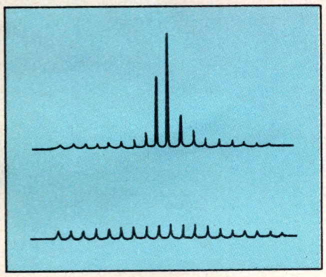

The pros, the cons and the future of LEDs and diode lasers
Telecommunications-transmission systems present a design challenge, involving long distances and high reliability. This, the first of a series from GTE specialists in fiber-optic telecomm design, sets forth the criteria and tradeoffs that apply to the all-important first step in designing fiber-optic telecomm systems and equipment—the selection of an emitter. The pros and cons of the most popular sources, LEDs and diode lasers are thoroughly examined, creating a reference source of long-range value.

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Using the CMOS NSC800 in a microcomputer
The NSC800 μP family, fabricated with a high-performance version of CMOS, will help reduce power dissipation, simplify regulation and improve noise immunity. Operating from a 4-MHz clock, the μP chip dissipates less than 5% of the power used by previous NMOS chips. With an architecture resembling that of the Z80 and a bus structure similar to that of the 8085, the NSC800 is software-compatible with both processors. Even better, it puts all these capabilities to use in a data-acquisition system.

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Featured Next Issue

In the April 26 issue:

Special Report on Electro '80: An in-depth look at the technical sessions, plus a special section detailing the most significant product introductions at the show... Special Report on Counters: Low-end counters get intelligence... Two new test instruments improve on cost/performance tradeoffs... A new 16-bit μP support chip... Selecting the right photodetector for a fiber-optic system.

‘With all the talk about single channel CODECs, why is the Cheshire Cat still grinning?

© PMI 1979

Because PMI's *NEW* DAC88/89 and DMX88 make *shared* CODECs faster, easier and less costly!

"Would you tell me please which way I ought to go from here?" Alice asked the Cheshire Cat.

"That depends a good deal on where you want to get to," said the Cat.

"I don't care where, so long as I get *somewhere,*" said Alice.

"Then it doesn't matter which way you go," said the Cat.

With that passage from *Alice in Wonderland,* written more than 100 years ago, Lewis Carroll summed up the feeling of today's designers of telephone switching equipment. They all want to convert their products to PCM and they don't care which way they go as long as they get there.

They *should* care, of course, because to go the wrong way can be costly. So the easiest way out of the woods is to follow the trail blazed by PMI's PCM Carrier, CO and PABX customers, who have been using multichannel shared CODECs with our COMDAC® companding digital-to-analog converters since 1975, when we first started off-the-shelf deliveries. Since 1976, PMI has delivered more lines of shared codec than all single-channel codec manufacturers combined . . . *over a million* lines in 1979 alone!

NOW—PMI's new DAC-88 (μ-law) and DAC-89 (A-Law) COMDAC® companding D/A converters, *AND* PMI's new DMX-88 8-channel de-multiplexer, offer faster settling time, higher accuracy, and lower idle channel noise.

This makes shared codecs easier to use, and permits sharing more lines, while at the same time, reducing noise, distortion and quantitizing error.

As these tables and photographs show, shared codec users reduce the cost and improve the reliability of their systems several ways:

- Smaller chip areas mean higher reliability as well as lower average cost per line.
- Fewer, smaller packages save board space, and, more important *ALSO* improve reliability, since solder joints to PC boards are a primary source of failures in I.C. based circuits.
- Power consumption per line is lower than most single line codecs, which saves power supply cost as well as improves reliability.

PMI's CODEC parts are *all* available right now. And they're all backed by PMI's reputation for high quality and reliability with our world famous Triple Passivation Process, and most have second sources.

You already know how easy it is to get lost in Linear Wonderland, so let PMI be your guide. If you can tell

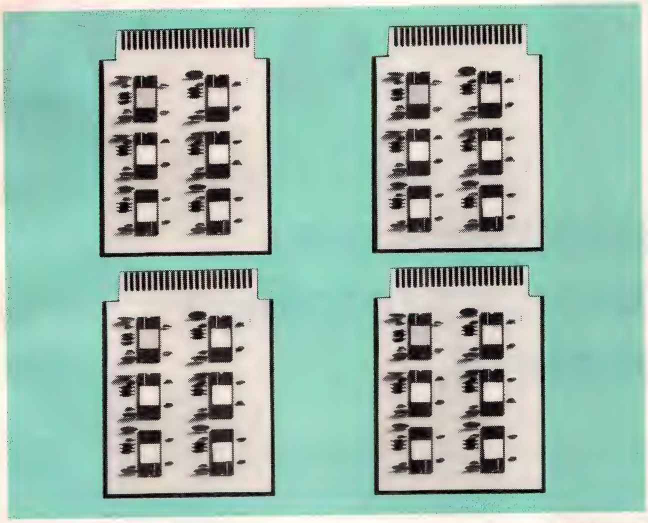
PMI 24-Channel Shared CODEC IC Cost (3 Encoders at 8 Lines Each, Plus One 24-Line Decoder)

Device	**Cost at 100 pcs**	**Quantity Required**	**Total Cost**	**Total Power Dissipation ±15V Supplies**
DAC88/89 COMDAC® Converter	$9.00	4	$ 36.00	828 max.
SMP81 S/H Amplifier	9.50	3	28.50	540 max.
CMP81 Comparator	3.00	3	9.00	459 max.
25L02 S.A.R.	3.30	3	9.90	525 max.
Op86 Op Amp	2.50	1	2.50	210 max.
REF82 5 Volt Reference	2.95	1	2.95	42 max.
24-LINE TOTAL EXCLUDING MULTIPLEXERS		15	$ 88.85	2604 max.
AVERAGE/LINE EXCLUDING MULTIPLEXERS		**0.63/line**	**$3.70/line**	**109 max. per line**
MUX88 8-Channel MUX	7.50	3	22.50	495 max.
DMX88 8-Channel DeMUX	7.50	3	22.50	495 max.
24-LINE TOTAL INCLUDING MULTIPLEXERS		21	$133.85	3594 max.
AVERAGE/LINE INCLUDING MULTIPLEXERS		**0.88/line**	**$5.58/line**	**150 max. per line**
Intel published (24 pins 100 piece price 22,000 mil²)		1	$ 17.00 per line	230 typ.
Mostek published (16 pins 100 piece price 31,280 mil²)		1	$ 32.25 per line	80 max.

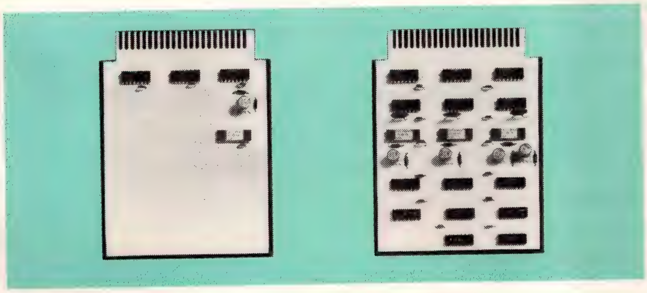
(NEITHER Intel nor Mostek includes the Digital Multiplexer)
*Specified at d.c.

Chip Areas and Package Sizes for a PMI 24-Channel Shared CODEC (Three Each 8-Channel Encoder Plus One 24-Channel Decoder)

Device	**Chip Area (mil²)**	**Package Size**	**Number Required**	**Total Chip Area**	**Total Pins**
DAC88/89 COMDAC® Converter	9.996	18 DIP	4	39,984	72
SMP81 S/H Amplifier	6,996	14 DIP	3	20,898	42
CMP81 Comparator	2,730	8 TO99	3	16,380	24
25L02 Succ. Approx. Register	2,880	16 DIP	3	27,405	48
OP86 Op Amp	2,880	8 TO99	1	2,880	8
REF82 5 Volt Ref.	2,520	8 TO99	1	2,520	8
MUX88 8-Channel MUX (Encode)	4,838	16 DIP	3	14,514	48
DMX88 8-Channel De-MUX (Decode)	4,838	16 DIP	3	14,514	48
TOTAL FOR 24 LINES AVERAGE PER LINE			**21 0.88**	**139,095 5,796**	**298 12.4**



24-Channel PCM CODEC System Implemented with Single Channel CODECs



24-Channel PCM Shared CODEC System (includes MUX's)

us where you want to be, we can tell you how to get there. Then we'll *both* be grinning like the Cheshire Cat, while everyone else is still trying to find the road.

Send in the coupon below for further details or—even better—for an 8-channel demo set and an engineer to demonstrate it for you.

If someone beat you to the coupon, write to us. Or circle #200 for literature.

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CIRCLE NUMBER 200

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CIRCLE NUMBER 7

Reader Feedback

New way isn't always the best way

What this industry needs is less effort spent on new and better ICs and more effort spent on improving yields so that the demand for existing products can be satisfied. There is nothing worse than having to design out (or avoid designing in) devices that have been around for three or four years but are in such short supply that they are simply not available.

One example is the very convenient 74LS240 series of buffers, whose existence must simply be ignored if the proposed product is to be sold within the next year. Bipolar PROMs are an even better example. Over the past few years, other publications along with yours have indoctrinated designers about the advantages of replacing several packs of random logic with a single, suitably programmed PROM. However, with lead times stretching to two years and several manufacturers hinting about dropping the product, one would have to be foolish to even consider bipolar PROMs for logic replacement. And then, of course, there is the perennial shortage of logic itself. I, for one, would like to see a moratorium on new developments until existing products are adequately supported.

Another thing: You guys really need to be more careful when selecting headlines for your feature articles. I am referring specifically to one on the cover of the March 1, 1980 issue reading "Meet the First Single-chip Floating-point Processor." Surely you must know that single-chip floating processors have been around for a long time. Obvious examples are the Am95111 and Am9512 made by Advanced Micro Devices and a similar device made by National Semiconductor. While the latter is a very slow, calculator-derived product that uses decimal arithmetic, the AMD devices tie directly across a microprocessor bus and have quite respectable speeds of less than 60 μs for a single precision.

After reading the article behind the headline, I found the most significant feature of the new NS16081 device to be that it performs multiplications in less than 10 μs—that's mainframe performance! A much better (and accurate) headline would have been: "Single-chip Floating-point Processor Multiplies in 10 Microseconds."

Hal Chamberlin
Vice President, Engineering
Micro Technology Unlimited
P.O. Box 4596
Manchester, NH 03108

Ed. Note: It's true that the AMD9511 and 9512 have been around for a while. So, technically speaking, our cover line was not totally accurate. What we meant to stress is that the tightly coupled National NS16081 is the first to act as a coprocessor with the host CPU. The AMD devices work as a slave, and do not monitor instructions. Thus, they are strictly peripheral chips.

A close scrape does not a skive make

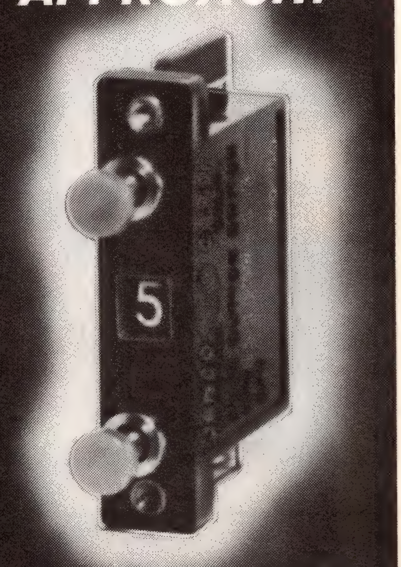
Skiving is used in electronics to shave film from foil and, in TMI's inlay process (Feb. 15, 1980, p. 25), to cut a shallow groove in metal strip. Unfortunately your report also calls it "scraping"—which it isn't. As a manufacturer of skiving tools, I'd like to clarify the lingo.

You skive (rhymes with "drive") with a sharp blade-like tool, so that

(continued on page 14)

Electronic Design welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to Editor, Electronic Design, 50 Essex St., Rochelle Park, NJ 07662. Try to keep letters under 200 words. Letters must be signed. Names will be withheld upon request.

THE DIRECT APPROACH!



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CIRCLE NUMBER 8

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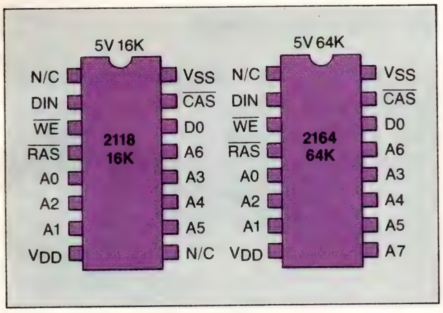
Dynamic Performance

Intel delivers the 100ns, 16K 2118: Your ticket to a new generation of dynamic RAMs for the 5-volt world.

Today the spotlight's on even higher performance systems featuring faster speeds, lower power and higher density. Now Intel's industry standard HMOS* 2118 gives designers the fastest access ever in a dynamic RAM, lowest power, and 16K density. Even more important, the 2118 is the first of the new generation of dynamic RAMs operating on a single 5V supply and setting the stage for tomorrow's 64K dynamic RAMs when they arrive.

Dramatic advantages for microcomputers

Designers of new high performance microcomputer systems, like those using Intel's 16-bit 8086 or our new 8MHz 8086-2, require faster memory and more of it. Our 2118 is made to order. Its single 5V power supply operation makes it the first dynamic RAM ideally matched to the world of microprocessors. You'll get the highest density available in a compact, industry standard 16-pin DIP—assuring upward compatibility with higher density devices of the future. Plus your choice of three speed versions, so you can tailor memory precisely to system requirements. As a microcomputer memory, the 2118 means simpler, more compact designs, and outright higher performance.



Rising star in main memory

It's a 5-volt world for mainframe memory designers, too. The 2118 gives you a head start on 5V-only 64K RAMs with a producible 5V 16K that's here today. The 2118 also delivers the speeds you need for high performance main memory. With a maximum access as fast as 100ns, you get speeds as fast as many static RAMs, but with lower costs and lower power to boot.

Premiere power saver

Whether you're designing microcomputers or mainframes, the 2118 means dramatic improvements in power dissipation. With 150mW active and 11mW standby, you'll reduce device power consumption threefold compared with 3-supply devices. It means reduced overall system power dissipation, simpler designs, and far more economical cooling solutions.

HMOS for reliability and availability

Intel's HMOS is the high performance technology that has revolutionized the semiconductor industry, combining improved scaling, speed, power and density with reliability and producibility. We've already delivered over 18 million leading edge HMOS devices: from our industry standard 2114A and 2147 static RAMs to our industry standard 16-bit 8086 microprocessor. Today Intel brings the performance advantages of HMOS to dynamic RAMs, too.

2118 FAMILY			
	2118-3	2118-4	2118-7
Maximum Access Time	100ns	120ns	150ns
Maximum Active Power	150mW	137mW	126mW
Maximum Standby Power	11mW	11mW	11mW

Start your production today

Our 16K 2118 is in volume production and on distributor shelves now. To order, or for more information, including our HMOS Reliability Report #18 and Article Reprint -71 on designing with the new generation dynamic RAMs, contact your local Intel sales office or distributor. Or contact Intel Corporation, Literature Department, 3065 Bowers Avenue, Santa Clara, CA 95051. (408) 987-8080.

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*HMOS is a patented process of Intel Corporation.

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PRESENTED BY: Mark D. Walby, Product Manager, EG&G Reticon. Mr. Walby holds a BSEE from MIT and an MSEE from Stanford University. He is a recognized circuit and system designer, author and speaker.

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CIRCLE NUMBER 9

Reader Feedback

(continued from page 11)

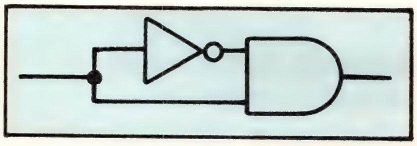
material comes off in continuous shavings or parings, as it does with a carpenter's plane. Skiving is a fairly fast operation. Scraping takes off material in tiny flecks, like filings, and is, by one test, fifty times slower than skiving; it is used commercially only when the objective is to remove as little material as possible.

L. T. Fleming
President

Innes Instrument Co.
1830 Reiter Dr.
Pasadena, CA 91106.

A reader injects some humor—and logic?

Is "injunction logic" ("The German Connection," March 1, 1980, p. 24), used to make "never" gates?



Dan Sheingold

Analog Devices
P.O. Box 280
Norwood, MA 02062

Fujitsu processor is the real news

The News and Technology section in your March 1 issue (p. 24) contained a die photo and article describing a 100,000-gate CMOS processor (173,000 mils^2). The processor is a Fujitsu design and product, not Hitachi.

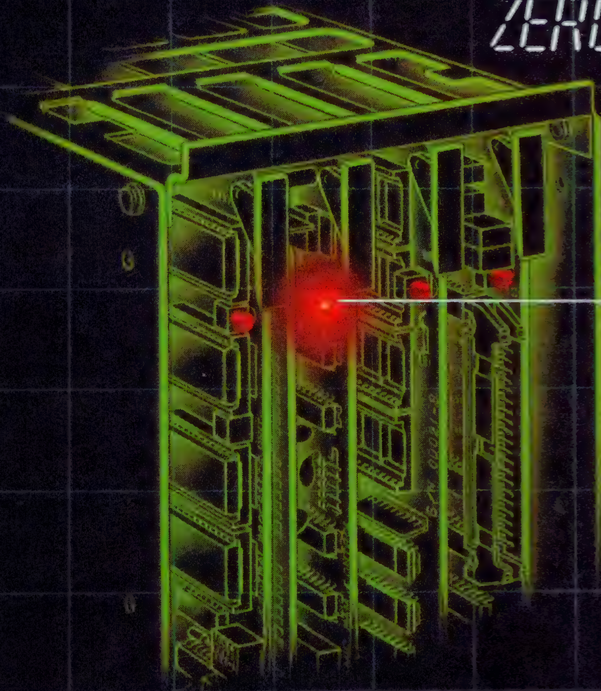
Alan Heimlich
Product Support Manager

Fujitsu Micro Electronics, Inc.
2945 Oakmead Village Court
Santa Clara, CA 95051

OS, not I/O

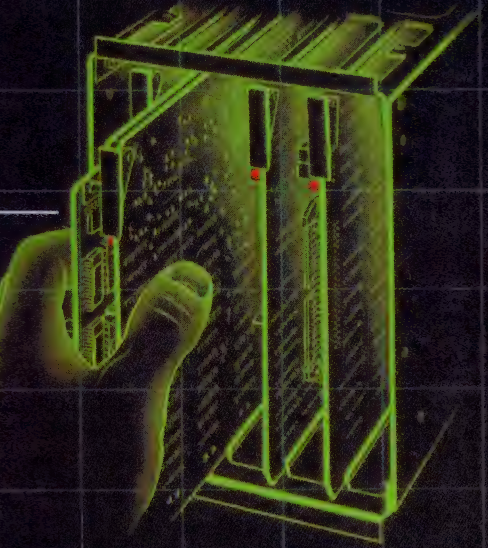
Table 2 of our special report on microcomputer operating systems (March 15, 1980, p. 223) contains an error in its head, which should read "Summary of Major OS Characteristics Ranked by Usage." Blame the mistake on our Software/Systems Editor, Max Schindler, whose byline was inadvertently omitted. In addition, he will appreciate any corrections or comments on the pullout chart.

SCOUT™ MINICOMPUTER WITH ISOLITE™ INSTANT SELF-TEST FOR VIRTUALLY ZERO DOWNTIME.

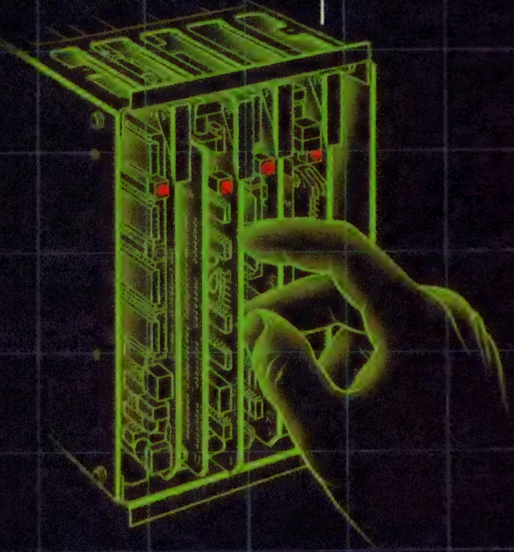


ISOLITE CIRCUIT AUTOMATICALLY TESTS EACH BOARD IN SCOUT SYSTEM.

RED LIGHT SHOWS BOARD BEING TESTED. IF LIGHT GOES OFF, BOARD IS GOOD. IF LIGHT STAYS ON, BOARD IS BAD.



USER REPLACES BAD BOARD WITH SPARE 6.25" X 8.3" CARD IN 3 MINUTES. NO TECHNICAL PERSON OR OEM SERVICE ENGINEER REQUIRED TO MAKE REPLACEMENT. MAINTENANCE COSTS DRASTICALLY REDUCED.



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CIRCLE NUMBER 10

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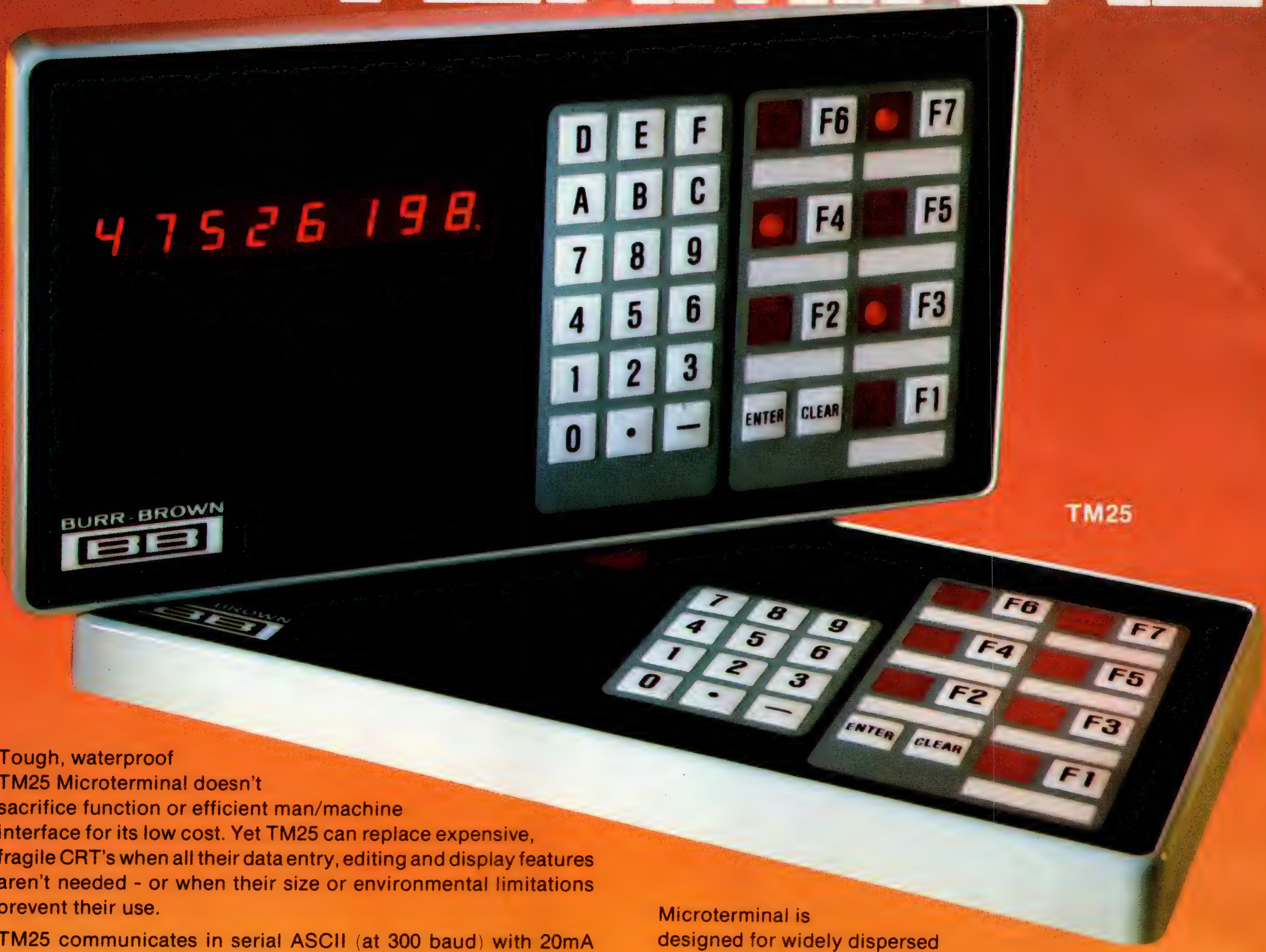

Tough, waterproof TM25 Microterminal doesn't sacrifice function or efficient man/machine interface for its low cost. Yet TM25 can replace expensive, fragile CRT's when all their data entry, editing and display features aren't needed - or when their size or environmental limitations prevent their use.

TM25 communicates in serial ASCII (at 300 baud) with 20mA current loop and RS232C/V.24 conditioning up to one mile from your CPU. Its buffered data feature allows message verification before transmitting - then sends data to the computer on-line at maximum speed.

Eight-digit LED display reports system data and visually verifies keyboard entries with hexadecimal (0-F) and numeric characters. Hex or numeric keyboard and function key pad offer tactile response. Seven function keys initiate preprogrammed computer action with single key input. Function indicators confirm CPU response or call for operator action.

Microterminal is designed for widely dispersed control and data communication networks - in machine and process control, inventory control, data collection, ATE - and can function as a console, control center or I/O terminal for diagnostic service.

Mount the 216 x 114 x 15mm module on any flat surface - a DB25 connector provides signal I/O and power. Warranted one year!

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CIRCLE NUMBER 180

NO. 9

NATIONAL ANTHEM

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NATIONAL ANTHEM

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And National makes more kinds of those practical, reliable Series/80 products than any other manufacturer.

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The Series/80 Family includes CPUs, memories, controllers, analog and digital I/O, peripheral controllers, firmware, card cages, power supplies, cables and just about anything you need for just about any application.

Test procedures make them practically perfect. National's boards are designed to be functional, easy to design in and totally consistent in operation. That's why test points have been designed into each board. So testing becomes an integral part of the design phase and continues throughout National's unique dynamic high temperature burn in.

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All from the Practical Wizards who finally brought space-age technology back down to earth.

National's enhanced 8049s have arrived.

National's 8049 μP is smaller, faster and consumes less power. And it's available now.

National is now in production with their industry standard INS8049 μP. The ROMless version (8039) is available right now at your local distributor.

The INS8049, which features 2K x 8 ROM, 128 x 8 RAM and 27 I/O lines on a single chip, is currently available in both 6MHz and 11MHz versions.

And due to their leading edge XMOS™ technology, National's 8049s boast a myriad of transparent improvements. All of which result in considerable reductions in systems costs.

For example, cycle times for the 6MHz and 11MHz models are 2.5 and 1.36μsec, respectively. A battery charging circuit and a Schmitt triggered interrupt are also on-chip, which makes the 8049 ideal for sophisticated battery-operated applications.

The INS8049 consumes 40 to 50% less power in full operation and 12 to 35 times less power in standby mode.

The INS8049 μP is in fact only one of several Series 48 Family devices already in production. All of which are fully supported by National's STARPLEX development system with ISE. The chart below describes all seven family members.

National's enhanced 8049 μPs give you the kind of single-chip practicality you've been waiting for. For less than you ever thought possible.

PART NUMBER	RAM	ROM
8035	64 x 8	0
8038	128 x 8	0
8040*	256 x 8	0
8048	64 x 8	1024 x 8
8049	128 x 8	2048 x 8
8050*	256 x 8	4096 x 8
8243	16L I/O EXPANDER	

*These parts are proprietary yet pin-compatible with the 8048 and 8049.
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PAL's standard AND-OR logic and flexible I/O programming provides hitherto unknown design and production efficiency. Because logic modifications can be made more quickly and easily with PAL than with discrete random logic.

National is producing TTL-compatible PALs with the same time-tested technology used to manufacture PROMs. And with 15 different PAL devices to choose from (including both mil and commercial temp), logic design efficiency and reliability is truly maximized.

National's high volume production capability means a dependable source of reliable PALs at the lowest possible cost.

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Working wonders on the 2147 4K static RAM.

National's new MM2147 static RAM is a 4096-word by 1-bit random access memory that uses National's XMOS™ N-channel silicon-gate technology.

All of the 2147's internal circuits are full static. And they therefore need no clocks or other refreshing for operation. All data is read out non-destructively, and has the same polarity the input data has.

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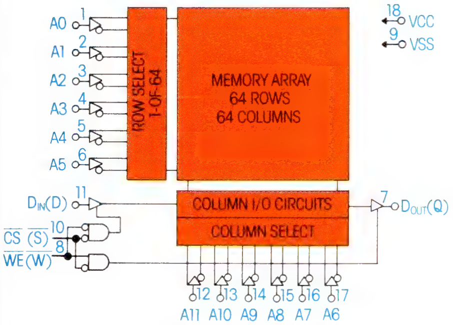
The 2147 has other impressive features as well. All its inputs and outputs are directly TTL compatible. It has automatic power down, and high speed – down to 55ns cycle time. It has a TRI-STATE® output for bus interface, separate Data In and Data Out pins, and a standard 18-pin dual in-line package.

In addition to all this, the 2147 is available right now.



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Introducing STARPLEX™ with ISE.™

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The Practical Wizards have created an easy-to-use development tool that helps design engineers do their whole job on the STARPLEX development system.

STARPLEX can not only develop software for 8080, 8048, 8049, 8050, 8070, NSC800, 8085, and Z-80 microprocessors plus BLC/SBC Series 80 boards, but now with ISE (in-system-emulation) you can also test, analyze and debug prototype hardware/software for the same products.

The ISE module is a separate unit incorporating its own CPU, 32K bytes of user-programmable memory and all the necessary logic for breakpoints, tracing and memory mapping.

With ISE, you can simultaneously run two prototype microprocessors (in any combination). So for the first time, you can have real-time emulation or debugging in a multi-processor environment.

National's easy-to-learn ISE software comes completely integrated into the STARPLEX system, including the unique Automatic Testing or "In-File" capability. In-File is an automatic testing mode that will implement a predefined sequence of tests. ISE can also record those results to show exactly how each part of the system performs during tests.

Our symbolic debugging capability provides not only the usual breakpoint conditions, but also a "coast" command which allows you to continue executing a program after the breakpoint combination has been satisfied.

STARPLEX with ISE offers features not found in any other development system, yet it costs substantially less to own and operate than any competitive system.

Practical Wizards, indeed.

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What's new from the National archives?

003 ☐ MM2147L Data Sheet

025 ☐ PAL Brochure

028 ☐ STARPLEX and ISE Data Sheets

030 ☐ INS8049 Data Sheet

035 ☐ Additional Series/80 Information

036 ☐ Optoelectronics Handbook ($3.00)

Enclose check or money order based upon appropriate currency. Make checks payable to National Semiconductor. Allow 4-6 weeks for delivery.

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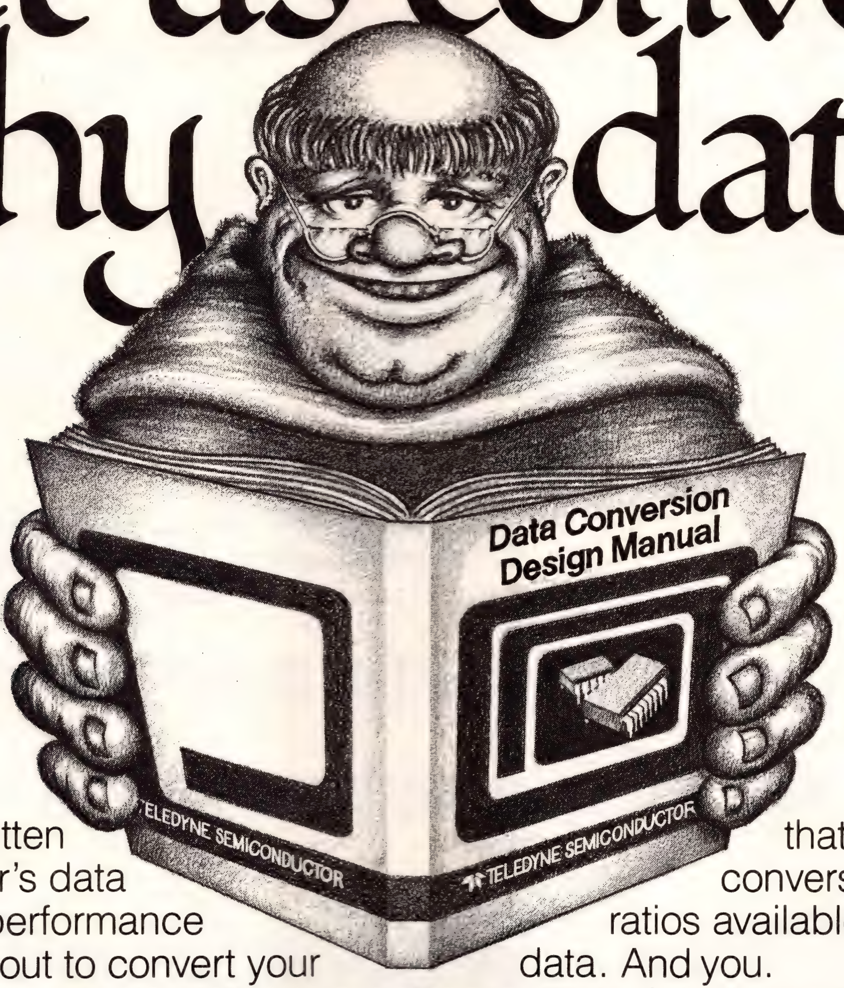
Let us convert thy data.



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MOTEL makes Motorola, Intel buses interchangeable

Up to now, peripherals and memories connecting to Motorola's widely used EXORcisor bus could not connect to Intel's Multibus or vice versa—without adapting circuits in between. A circuit developed at Motorola (Austin, TX) called MOTEL (for Motorola and Intel) solves the compatibility problems by making the buses interchangeable—virtually by itself.

Slated to be introduced at Electro '80, the MOTEL circuit requires three input pins when incorporated into a peripheral or memory IC. With a Motorola-type processor connected, the pins are Address Strobe, Data Strobe and Read/Write. When the same IC is used with an Intel-type processor, the same three pins are connected to Address Latch Enable, Read and Write, respectively. The MOTEL circuit automatically adapts to whichever type of processor is connected. Neither extra pins nor factory options are needed to indicate which type of MPU is connected.

The key to the MOTEL concept is that the state of one of the control signals is latched with Address Strobe/Address Latch Enable. During Address Strobe and Address Latch Enable, the MOTEL circuit saves the state of the pin alternately connected to Data Strobe and Read. A high on that pin indicates that the peripheral/memory is being driven by an Intel-type processor, while a low indicates a Motorola-type MPU.

However, comparing differences in the control signals on the two buses shows that it's easier to convert Motorola-type control signals to the Intel-type signals. A section of a small-scale IC allows Motorola MPU users to use Intel-type peripherals, as well as generic memories.

However, Intel-type MPU users will not be able to take advantage of Motorola type peripherals as easily. While Data Strobe can easily be generated by ORing Read and Write with a single NAND gate, the Motorola-type Read/Write signal, which must extend beyond Data Strobe, is more of a problem.

One of the first parts to include a MOTEL circuit is the MC146818 Real-Time Clock plus RAM, a CMOS peripheral designed for use with CMOS or NMOS μPs. The MC146818, which includes 50 bytes of CMOS RAM for general-purpose use, also maintains time-of-day and a century-long calendar using one of three crystal frequencies. Time, calendar and control information is read and written as bytes of RAM.

The MOTEL circuit allows the part to directly interface with many multiplexed-bus MPUs. Since the MC146818 is difficult to use with a non-multiplexed MPU, a nonmultiplexed version will also be introduced. The only difference is that a larger package will be needed to accommodate the extra address pins.

Fiber optic links transmit power

More efficient photovoltaic cells may pave the way for power, as well as signal, transmission on fiber-optic cables, in environments where metallic conductors may present safety hazards. Test data released by Sandia Laboratories (Albuquerque, NM) for example, show power-conversion efficiencies up to 33.4% using a 890-μm square GaAs mesa diode receiving 820-nm wavelength laser-diode radiation. Although power levels were low (1.34 mW of optical power in the fiber bundle was converted to 0.45 mW of electrical power at the receiver), there are applications where such low power can be useful.

The tests, described by M.M. Robertson at this year's Electronic Components Conference (April 28-30 in San Francisco) measured the power conversion efficiency of a number of photovoltaic generators receiving broadband Xe arc light and monochromatic laser light from fiber-optic bundles.

Single 0.85-cm diameter solar cells from Varian produced 0.81 W of electrical power from 3.55 W of optical power injected into the fiber from an Xe light source. The maximum conversion efficiency, here, was 22.8%.

A Sandia photovoltaic cell provided a maximum efficiency of 17.7% when exposed to 0.43 W of unfocused Xe arc light, while a Motorola diode provided a maximum 14.3% efficiency with 0.63 W from the same source.

The best results, however, were obtained when the Hughes 890 μm square GaAs mesa diode was exposed to the 1.34 mW light output of a fiber bundle powered by a laser diode at 820 mm (33.4%). The efficiency of a tiny 300-μm diameter Varian GaAs dot cell climbed to 28.7% when exposed to a 1.95 mW light output at 803 nm wavelength.

The fibers used to couple laser light to the cells had core diameters of from 55 μm to 1000 μm; the bundles varied from 1.58 to 6.35 mm OD.

System employs multiple CPUs as masters or slaves

Multiple 8086 CPUs cooperate in an advanced small computer system that can handle up to 16 terminals or act as a front-end processor, communicating with an IBM-type host. Lazor Systems (Sunnyvale, CA) plans to unveil the LAZOR computer system at the upcoming National Computer Conference. It supports async and bisync protocols.

In a network with three internal buses, the 8086s operate as masters or slaves. A LAZOR system could incorporate a master, a slave task processor, one or more slave I/O processors, multiple I/O controllers and main memory (with or without ECC) up to 1 Mbyte.

The extensive software for LAZOR is based on a multilevel executive, LAZOR MLX. The interrupt-driven operating system provides task management, access alternatives and resource management.

The task manager schedules tasks for up to 16 concurrent users. Its runtime monitor and priority scheme provides dynamic switching at specified intervals, to guarantee the timely completion of applications.

The system provides three types of high-level disk-access. The indexed sequential method allows the user to access disk-resident data by a key record identifier. The relative record method allows random access by record number. The sequential method provides access beginning with the first record in a file.

The resource manager of the MLX provides memory management and timer services and allocates input-output devices. The memory-management routines dynamically allocate and deallocate memory and partition memory by task. The input-output routines assign physical I/O devices to logical I/O names, so that individual applications can be independent of particular I/O configurations.

UCSD Pascal-low-cost with users' group

Although most Pascal programs for μCs use the UCSD (University of California, San Diego) version of the language, there hasn't been much applications software available. So, users have banded together to do something about it.

The UCSD Users Group, set up by Datamed Research (Los Angeles, CA), intends to provide low-cost ($10) programs on 8-in. single-density floppies, which the user can adapt to his own equipment. CP/M-compatible disks will also be offered.

The service should prove welcome, especially in the light of criticisms leveled at the language's development. UCSD, developed in part with public funds, has been trademarked by the university's regents. Critics charge enrichment at the taxpayers' expense.

The new group is not related to the Pascal Users' Group (PUG), which deals with standard Pascal programs often not available in machine-readable form.

Briefs

An intelligent peripheral controller built from an enhanced MC6801 μC is coming from Motorola (Austin, TX). The MC68120 will become part of the hardware support for the MC68000 microprocessor. Slated to be unveiled at the Electro show in Boston, the MC68120 contains 2048 bytes of ROM space, 128 bytes of dual-ported RAM, a programmable serial I/O port, a counter/timer, an enhanced MC6800 CPU, and programmable I/O lines. In addition, six special registers called semaphore registers will help keep track of access to the dual-port RAM by more than one processor.

A new family of solid-state pressure sensors is truly miniature: less than 0.64-in. sq. and 31-in. thick. The 130 PC-series piezoresistive sensors will be announced by Micro Switch (Freeport, IL) at Electro' 80 in Boston next month. They will come in three ranges (0 to 5, 0 to 15, and 0 to 30 psi) and three basic accuracies. The 134PC supplies an uncalibrated full-scale output from 175 to 325 mV at approximately 15 psi; the 135PC is a laser-trimmed version, with a 150 mV ±2 mV full-scale output; and the 136PC, a temperature compensated version, supplies 100 mV ± 1.5 mV. All versions provide a linearity within ±0.5% of the full-scale output, and repeatability to within ±0.15%.

A 58-Mbyte, 14-in. Winchester disk drive is being produced by Shugart Associates (Sunnyvale, CA). With twice the capacity of the company's SA4000 models, the SA4104 drive shares the same interface except for the addition of one head-select line. The new unit will sell for $2500 in OEM quantities.

A quad op amp operates from a single supply voltage (+5 to +30 V) and consumes 40 μA per channel, typical. From Precision Monolithics (Santa Clara, CA), the OP-420 features a high open-loop gain of 1100 V/mV and unity-gain bandwidth of 150 kHz. Each op amp's common-mode rejection is close to 100 dB.

A stand alone MC6800-family μC-software development system is now available from Motorola Microsystems (Phoenix, AZ). The EXORset 30 development system features an XDOS operating system and the versatile BASIC-M programming language, which offers bit manipulation and trace capability. Basic-M can be used in an interpretive mode as well as in a compiled mode. The system comprises an MC6809 MPU, a 9-in. CRT, two 80-kbyte minidisks and 48-kbytes of dynamic RAM and will sell for $5995.

A vertical beltbed plotter that can replace a flatbed in many applications is coming from Calcomp (Anaheim, CA). The Model 970 will plot on cut sheets up to 52 in. wide and 80 in. long, and has a drawing resolution of 0.00049 in. at pen speeds up to 30 in./s. Four pens allow multicolor and multiple line-width plotting.

Software packages that evaluate system reliability and provide a two-dimensional drafting system are the latest offerings from COSMIC (University of Georgia, Athens, GA), the clearing house for public-domain software. TIGER (DOD-00070) uses Monte Carlo simulation to estimate system MTBF and MTTR. UPLOTE (DOD-00072) provides CRT-based interactive drafting. Both programs are written in Fortran for a CDC 6000 computer.

Small-diameter silica-core cable is on the way from DuPont (Wilmington, DE). The PiFax S-120 Type 40C has a 200-μm silica core (1250 μm OD), and bends to a 1.5-mm radius without breaking. The NA is 0.42, and the attenuation is less than 40 dB/km at 820 nm.

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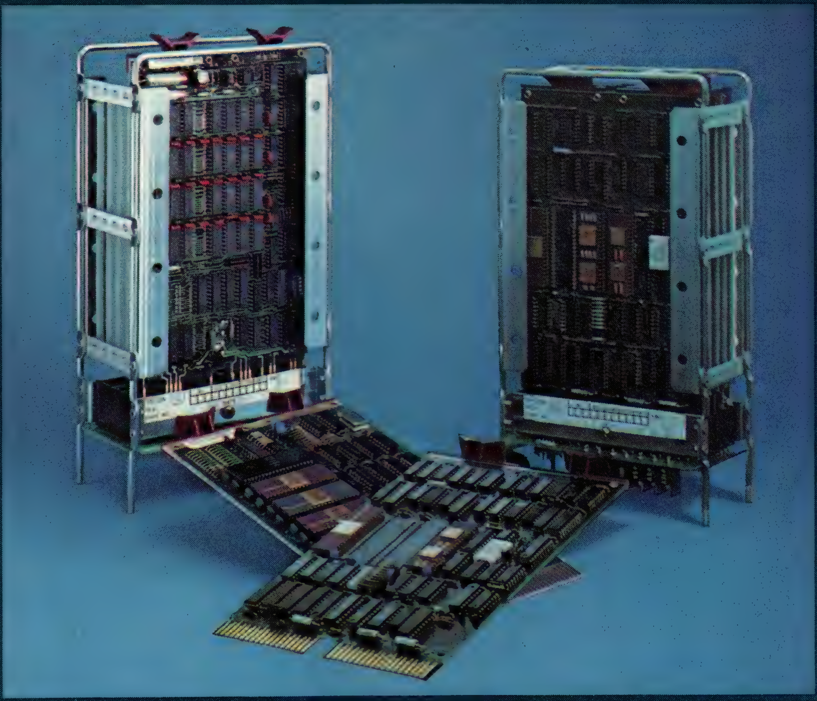

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CIRCLE NUMBER 15

GaAs ICs will handle the data crunch of 1980—and 1990

Gallium-arsenide ICs, once considered the toys of the military, are showing commercial promise, as manufacturers improve their capabilities to place hundreds and even thousands of gates on a single chip. Improvements to MESFET and JFET technologies, entirely new structures, changes in the methods of processing GaAs material (including the use of undoped materials and ion implantation) and a full range of support devices in GaAs are converging to produce rapid drops in gate delays and speed/power products and equally rapid surges in data-processing rates.

The performance potential of GaAs appears unmatchable by silicon and germanium. Compared to silicon technology, GaAs offers several major advantages: a higher electron mobility (typically 8500 vs 1500 cm^2/V-s) and operation at temperatures approaching 350 C (silicon starts to deteriorate at about 200 C). Germanium has an electron mobility of about 3900, but is extremely temperature limited—it peters out at about 60 C. Thus, GaAs is better suited to high-speed processing of huge volumes of data; but the supply and cost of materials may set boundaries to its use.

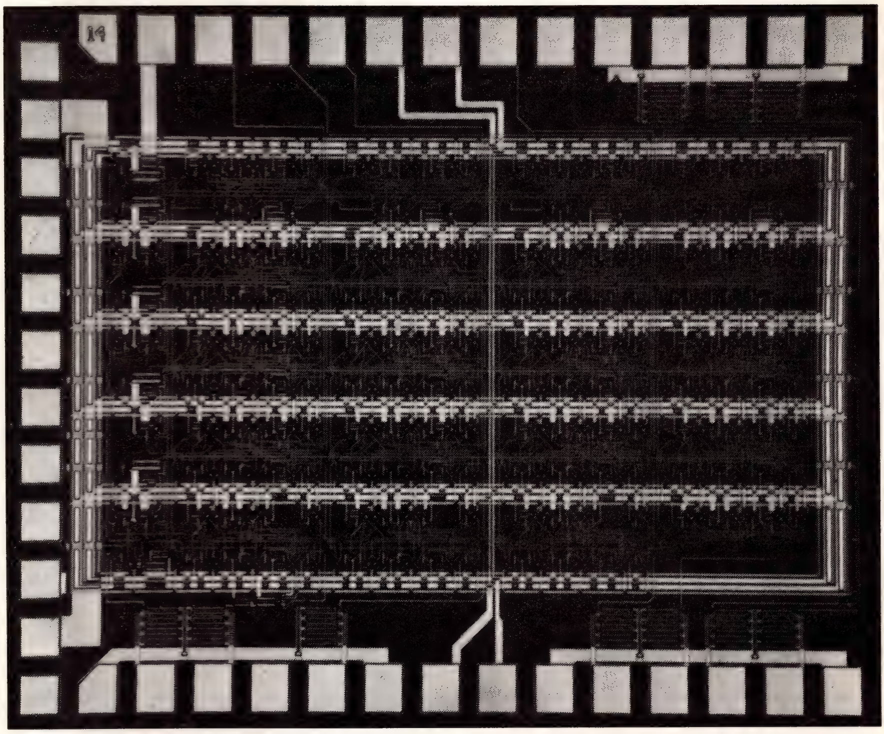
Predictions for GaAs devices highlighted discussions at the recent eighth annual symposium of the Metallurgical Section of the Northern California AIME. Richard Eden, principal scientist in solid-state electronics at Rockwell International Science Center (Thousand Oaks, CA) and D. Howard Phillips, manager of the Lockheed Microelectronics Center at Lockheed MSC (Sunnyvale, CA) foresee a strong future for GaAs, while Richard Pashley, manager of static RAM engineering at Intel (Santa Clara, CA) expects silicon developments to keep pace.

Rockwell International (Thousand Oaks, CA) has fabricated a 3 × 3-bit parallel multiplier with about 120 gates and gate delays of about 200 ps. Just out of the ovens is a 5 × 5-bit multiplier that has about 260 NOR gates and measures just 44 × 53 mils. An 8 × 8 multiplier is in design; it has 700 gates, a multiply time of 6 ns and a power dissipation of 300 mW.

A more unusual circuit, still in the evaluation stage, incorporates a dual 32-bit shift register as part of a code pattern generator that provides 4.3-billion patterns. Even operating at 1-Gbit data rate, the code would not repeat itself for 4 s. With more logic, the code generator could be set so as to never repeat in a lifetime, even at the high data rate.

In these devices, Rockwell depends on depletion-mode Schottky-diode FET logic, which uses less area for gate inputs than the direct-coupled FET logic employed in enhancement-mode devices. In areas of just 1 × 2 μm, the Schottky switching diodes offer F_T's of approximately 300 GHz—many times higher than the maximum frequencies available with other devices. Thus, the circuits fabricated with the diodes are much more compact than direct-coupled equivalents and offer better performance than enhancement-mode MESFETs and JFETs (see Table 1).

Eden projects the reduction of propagation delays to 50 ps using MESFETs with 1-μm gates, further reductions to 20 ps with 0.25 to 0.5-μm gates, and finally a reduction to 10 ps by combining the 0.25-μm MESFETs with low-temperature (about 77 C) op-



A 5 × 5-bit multiplier built with gallium arsenide at Rockwell International measures 44 × 53 mils.

Dave Bursky
Semiconductors Editor

eration. Beyond 10 ps, new structures (such as heterojunction bipolar or analog triode) might be used. While the gate delays decrease, the speed-power product will also drop—to below 10 fJ with 1-μm MESFETs, or to the same value with enhancement-mode MESFET or JFET circuits that have propagation delays of 100 to 200 ps per gate. Overall, the circuit will become more complex. This year, the first 1000-gate LSI circuits will be fabricated. By 1983, Eden predicts, complexity levels will reach 10,000 gates in the laboratory.

Reinforcing many of the comments by Eden, Phillips compares today's GaAs technology to NMOS and CMOS (see Table 2). He claims that the next-generation communications satellites and other aerospace applications will act as one of the main driving factors for the use of GaAs.

According to NASA estimates for 1977 and 1978, existing satellites handled about 10^{15} bits/year (generated) and analyzed or reduced about 10^{13} bits/year. For 1986, NASA expects the data handling requirements to increase to about 2×10^{16}. Unless the processing rates are boosted—for example by the use of GaAs LSI—the increase in data will outstrip the handling capability. Beyond 1986, data rates should increase another 12,000 to 16,000 times.

To fabricate LSI circuits in GaAs, better substrate materials must become available. Few manufacturers of GaAs can manufacture the material to the desired requirements, since the technology is still in its infancy. Table 3 shows some of the parameters that must be controlled to permit IC fabrication.

Materials cost is another factor that affects the commercialization of the components—currently, a wafer with a 3-in. diameter costs $250 to $500, assuming the wafer can be purchased. This price is almost 100 times that of silicon. However, the packing density of GaAs will permit more circuits to fit on the wafer, and thus help mitigate the cost.

Until recently, almost all GaAs material was chromium-doped to balance the impurities; now, undoped materials with resistivities of 10^8 Ω-cm can be pulled. Ion implantation and annealing (thermal for now, possibly laser anneal in the future) permit activations of 70 to 80%.

Just about every manufacturer of GaAs ICs has abandoned diffusion technology for ion implantation. In diffusion technology, arsenic can depart from the material at high temperatures. All the results collected thus far indicate that ion implantation will perform quite well. For example, with a silicon ion dose of $8 \times 10^{12}/\text{cm}^2$, resistivity becomes 368 Ω/sq., mobility is about 4000 cm²/V-s, activation approaches 55%, and doping hits $1.45 \times 10^{17}\ \text{cm}^{-3}$.

One of the last factors emphasized by Phillips is the need for total system compatibility. Not only will the GaAs circuits have to be partitioned for functions, but entire families of support circuits (from SSI to other LSI components) will have to be developed. Because the circuits are intended for high-speed operation, the logic swing must be made as small as possi-

Table 1. GaAs FET-based digital-IC technologies

	Enhancement mode				Depletion mode	
Logic circuit approach	Direct-coupled FET logic (DCFL)				Buffered-FET logic (BFL)	Schottky diode FET logic (SDFL)
Specific active device	MESFET	JFET	HJFET	MOSFET	MESFET	MESFET fast diodes
Typical logic voltage swing	0.5 V*	0.9 V*	1.5 V*	1 to 5 V	2.5 V	0.5 to 2.0 V
Chip complexity (present status)	Ring Osc (SSI)	Ring Osc only	Discrete FETs	Discrete FETs	20 gates	60 gates

*Voltage swing limited by gate conduction

Source: Rockwell International

Table 2. Status of semiconductor technology

	Current			Future (1985-1990)	
	NMOS	Bulk CMOS	SOS-CMOS	SOS	GaAs
Relative process maturity (Scale of 1-10)	9	8	4	2*	1*
Process complexity (No. of steps)	9 to 15	14 to 17	14 to 20	14 to 20	16
Logic complexity (No. of components, 2-input gate)	3	4	4	3 to 4	2
Packing density (gates/mm²)	100 to 200	40 to 90	100 to 200	200 to 500	300 to 1000
Propagation delay (ns) (typical value)	4 to 25 (15)	10 to 35 (20)	4 to 20 (10)	0.2 to 0.4 (0.3)	0.05 to 0.1 (0.07)
Speed-power product (pJ)	5 to 50	2 to 40	0.5 to 30	0.1 to 0.2	0.01 to 0.1

*As of 1980

Source: Lockheed MSC

Table 3. Processing goals—GaAs substrates

		Required for ICs	
Parameter	**Typical (1978–80)**	**Value**	**Uniformity (%)**
Donor concentration (cm⁻³)	10^{17}	10^{17}	5
Hall mobility (cm²/V-s)	Variable	3500	5
Resistivity (ohm-cm)	Variable	10^5	10
Dislocation density (cm⁻²)	10^4 to 10^5	10^2	10
Breakdown (2-probe) (V)	80 to 1200	800	10

Source: Lockheed MSC

ble. In many cases manufacturers are talking about a 2-V power supply for this "generation" of GaAs circuitry.

However, the voltage problem bothers manufacturers of silicon circuits also, as Pashley explains. Scaling of the NMOS devices results in extremely thin oxide layers that require considerably reduced voltages. But only a few procedures will reduce the voltage stress; for example, reducing the operating supply voltage or placing a voltage regulator on the chip. The first solution is preferable, but opens up more problems. In a mixed logic system, different logic levels would be present creating a compatibility problem. Here again, the solution seems to lie in an entire family of logic circuits that operate at a reduced supply.

Considerably more work in scaling has been done with NMOS than with GaAs. Intel's HMOS processes combines scaling with the clever use of implants. Silicon scaling has reduced the speed-power product from 1 pJ in 1977 to a projected 0.01 pJ in 1986; gate delays should go from 1 ns to 0.1 ns. Similarly, channel lengths (poly) will drop from 3.3 to 0.7 μm and gate oxides will be thinner, from 700 Å down to 100 Å. For oxides this thin, supply voltages will have to be 1 to 2 V.

To reach these goals, continues Pashley, some fundamental limits of materials and devices must be overcome: radiation-induced soft errors, shot noise, thermal noise, doping variations and even inter connect scaling. New factors, such as hot-electron trapping in the gate oxide and fringing effects, must be included in device models to ensure that the final, fabricated IC will work properly. ■■

Connector-emitter-detector package pushes coupling losses below 1 dB

Stephan Ohr
Components Editor

A low-cost fiber-optic connector package developed at Bell Laboratories goes beyond the familiar advantages of putting emitters and detectors inside the connector housing. Besides lowering the cost of fiber-optic components, simplifying the alignment of fiber ends to light sources and detectors, and eliminating the need to worry about fiber alignment, the package from Bell Labs' Murray Hill, NJ, facility is much less sensitive to the axial displacement of the fiber end at the emitter or detector junction than many currently available connection schemes.

The optical-link package contains a standard GaAlAs LED, with a 35-μm light-emitting opening on a TO-18 header, and a 1-mm-diameter sapphire microlens fitted into a biconic receptacle. With a 55-μm-core-diameter fiber (NA = 0.23), coupling losses between the receptacle and the connector plug are typically much less than 1 dB.

Developed by Bell Labs' B. H. Johnson, J. G. Ackenhausen and O. G. Lorimor and described at this year's Electronic Components Conference (April 28 through 30 at the San Francisco Hyatt Regency), the optical-link package combines some of the best features of the packaging schemes developed by Motorola and AMP (Electronic Design, April 12, 1979, p. 29) with the "sweet spot" microlens technology developed by Honeywell Spectronics (see p. 47), and is capable of up to 1-km transmission at 32 Mbits/s.

The sapphire microlens makes the connector relatively insensitive to axial displacement of the fiber at the LED junction: Axial separation in the range of 50 to 350 μm still provides 90% efficiency with coupling losses less than 1 dB. This is in sharp contrast to an end or butt-mating system in which the axis of the fiber and the LED aperture must be within 50 μm to ensure less than a 1-dB loss. In fact, the same LED with a 35-μm opening but without the microlens shows up to 50% losses after laterally moving the fiber as little as 17 μm.

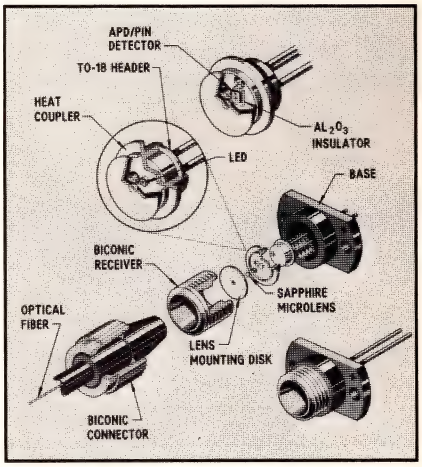
Familiar packaging scheme

The Bell Labs optical-link package is very similar to the economical packaging scheme provided for Motorola (Phoenix, AZ) emitters and detectors by AMP (Harrisburg, PA) with its plastic-ferrule connectors. With this scheme—called FOAC, for "fiber-optic active connector"—Motorola manufactures integrated single-chip light sources and detectors inside AMP's plastic ferrules. The semiconductor-connector combination offers transmission options up to 20 Mbits/s and coupling losses well below 2 dB.

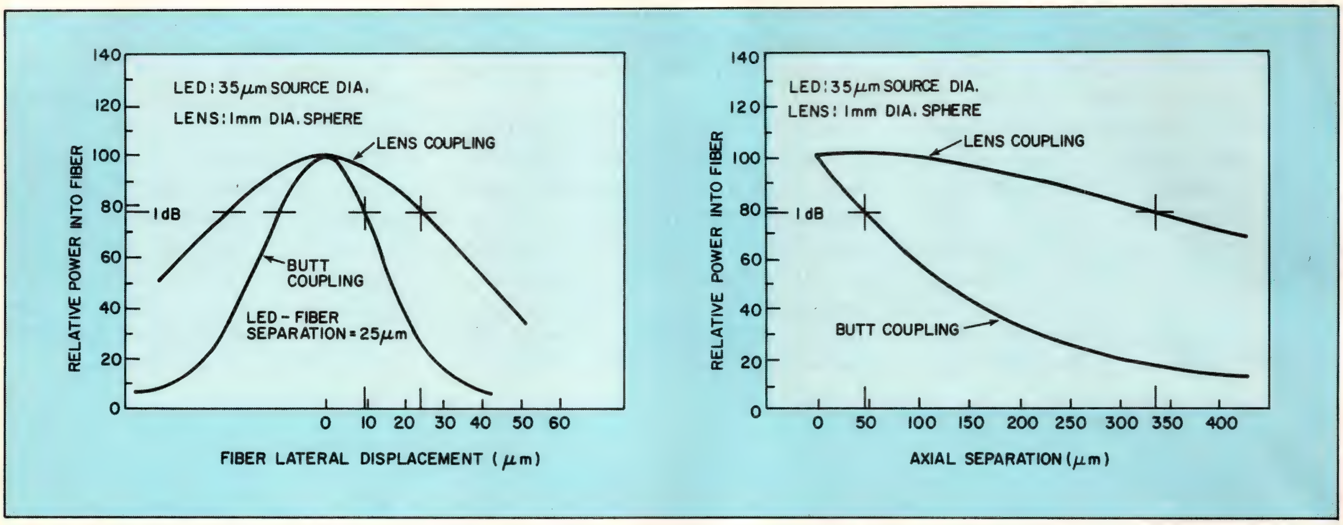
In this design, semiconductor chips are bonded directly to a small-diameter (204-μm) optical fiber (NA = 0.48), and sealed with epoxy inside the plastic ferrule. The fiber end that emerges from the plastic ferrule is polished to sit flush with the ferrule end.

Motorola's LED driver can put out up to 40 μW with a 40-mA input, while the receivers vary in responsivity from 0.15 μA/μW to 2000 μA/μW. More than one Motorola receiver, in fact, includes a built-in IC preamp that delivers an output on the order of 0.6 mV/μW.

The semiconductor drivers can be directly mounted with the AMP connector housing on a PC board. The Motorola package and the fiber-connector ferrule are inserted into oppo-



Emitters and detectors are mounted in the base of the connector receptacle in Bell Labs' packaging scheme. A sapphire microlens improves coupling efficiency.



LED-to-fiber power transfer is less sensitive to axial displacement in Bell Labs' connector package. With the microlens package, a fiber can be shifted laterally as much as 23 to 25 μm before showing a 1-dB loss. A butt-coupled fiber, in contrast, shows a 1-dB loss after just 10μm shift off the axis.

site ends of the barrel, and pushed in until they meet at the center. The press fit ensures a close end-to-end mating of the optical fibers.

However, Bell Labs' research suggests that a butt-mating scheme like this can be very sensitive to lateral and axial displacements of the fiber ends—and if it weren't for the close tolerances of the AMP metal housing into which the ferrules are pressed, the connector would probably show losses greater than 2 dB. Instead, by placing a 1-mm-diameter sapphire microlens over the emitting aperture of its LED, Bell Labs expands the light-emitting window of the connectorized emitter and duplicates the "sweet spot" microlens technique developed by Honeywell Spectronics (Richardson, TX).

In Spectronics' drivers and receivers, a high-index glass bead is attached to the emitting or detecting aperture of the silicon chip. The device sits on a BeO ceramic substrate in a TO-46 can with an open window. Because of the bead, the emitting aperture, or sweet spot, on the surface of the window is more than 300 to 400 μm in diameter—wide enough to promote efficient coupling with a wide variety of cable types and diameters.

LEDs using the Spectronics microlens typically are capable of launching up to 1500 μW into a 100-μm-core-diameter fiber, with little more than 100 mA at 1.6 V. Optical fibers within the diameter of the sweet spot on the TO-46 window, however, can tolerate as much as 100-μm displacements from the axis with little apparent loss. ▪▪

Simulator brings mini capability to μC-development tools

A universal simulator—a powerful tool limited in the past to users of mainframes like the DEC System 10 or 20—has been added to the μC designer's arsenal by the Boston Systems Office (Waltham, MA). Any PDP-11 can serve as the host.

The SI/MICRO-11 simulator, which BSO plans to demonstrate at Electro '80 in Boston, speeds-up μC software development not only by providing the target software with a make-believe μP environment but also by putting minicomputer tools in the designer's hands. Using debugging aids often more sophisticated than the host computer itself, the simulator works on object code either provided by one of BSO's cross-assemblers or downloaded from another development system. Transferring the debugging to the simulator, in addition to speeding up the function, will free the MDS for emulation and system integration.

LSI/MICRO-11 debugging tools include trace and break functions triggered by execution at a given memory location or register, ROM/RAM segmentation, program modification in an interactive mode, redefinition of symbols, complete implementation of symbolic jumps, and a DMP command that outputs the modified object file and revised symbol table.

Since the simulator steps through the same instruction cycles as the target μC, it mimicks I/O and interrupts realistically. Software interrupts can be generated anywhere in the program. The user can define I/O procedures with the help of macros—which also allow him to customize the debugger for his specific needs.

At present, simulators for the 8085, Z80 and 1802 are available, with those for the TMS9900 and M6800 to follow by midyear. BSO has also been offering SI/MICRO-10 simulators (running on DEC systems) for the TMS1000, 8048 and 8080; they will be converted as the market develops.

In addition to the simulator software (which costs $2000 to 3000), BSO offers complete simulator systems, including PDP-11 hardware. The smallest, supporting five simultaneous users—each of whom can work on a different chip—goes for $27,000; the largest system uses a PDP-11/70 and supports over 20 users. ▪▪

Max Schindler
Software Editor

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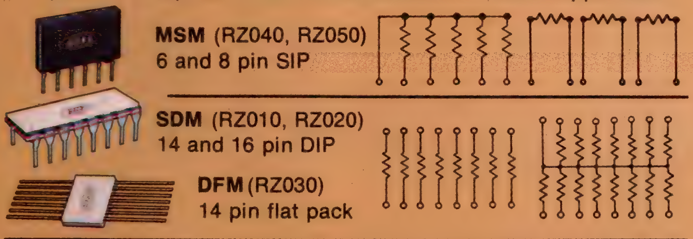

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CIRCLE NUMBER 16

TV cameras, computer and printer make hybrid inspection a snap

With large-scale hybrid microelectronic circuits growing more complex—a 2 × 2-in. device may contain 60 chips and over 700 wire bonds—visual inspections to stringent military standards are tedious and error prone. Proper hybrid inspection is so critical that the product assurance group at ILC Data Device Corp. (Bohemia, NY) designed their own in-house system.

Unsatisfied with commercially available inspection equipment, the group created an automated inspection system that is 98% more accurate and 80% faster than present techniques. Closed-circuit TV cameras peer down through two binocular microscopes to the hybrids. A μP-based computer controls the movement of a very accurate x-y table, and the sequence of wire bonds and chips to be inspected. Finally, a printer and keyboard eliminate the most time-consuming inspection task—report writing.

The hybrid under inspection sits on the computer-controlled x-y table, and the computer—not the inspector—selects the "target" or wire bond to be viewed. A magnified picture of the hybrid is projected on a big-screen TV monitor by the closed-circuit TV cameras. Since the computer controls the entire sequence of operations, it ensures the accurate inspection of all wire bonds and chip placements that must be inspected.

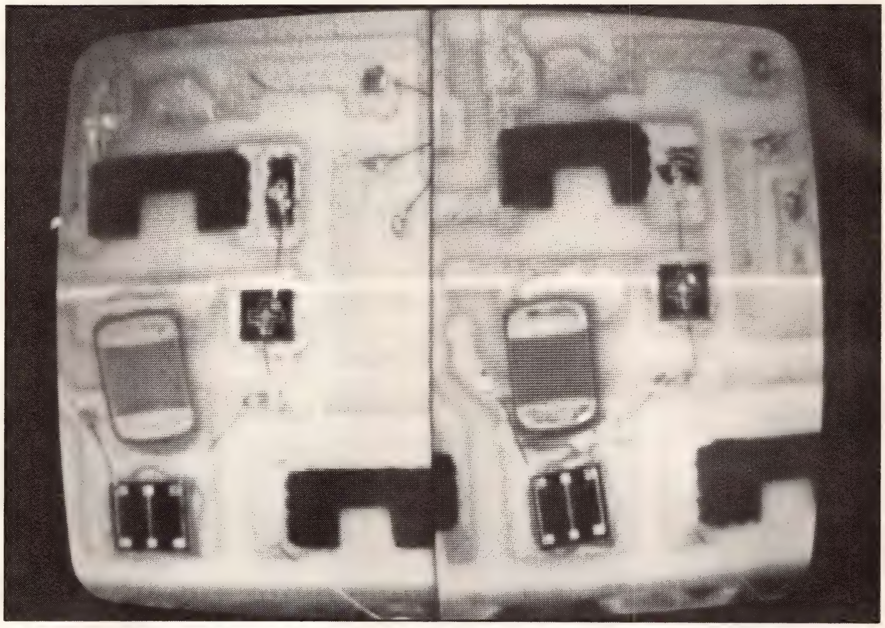
To conquer the time-consuming task of report writing, the system has a printer under computer control. A code number identifies each type of defect seen by the inspector. When a defect is spotted, the operator enters the appropriate code on the system's keyboard, and the type of defect plus its location are automatically printed out. Thus, conventional report writing no longer exists.

The principle behind the automated inspection system is a time-honored one—comparing a known good device against a part to be tested. One TV camera zeros-in on the good device while the other "sees" the identical wire bond or chip in the hybrid under inspection. Instead of a "live" good hybrid, a video tape of a good part can be used for comparison. Both images are displayed side-by-side on the TV monitor-in a split-screen image.

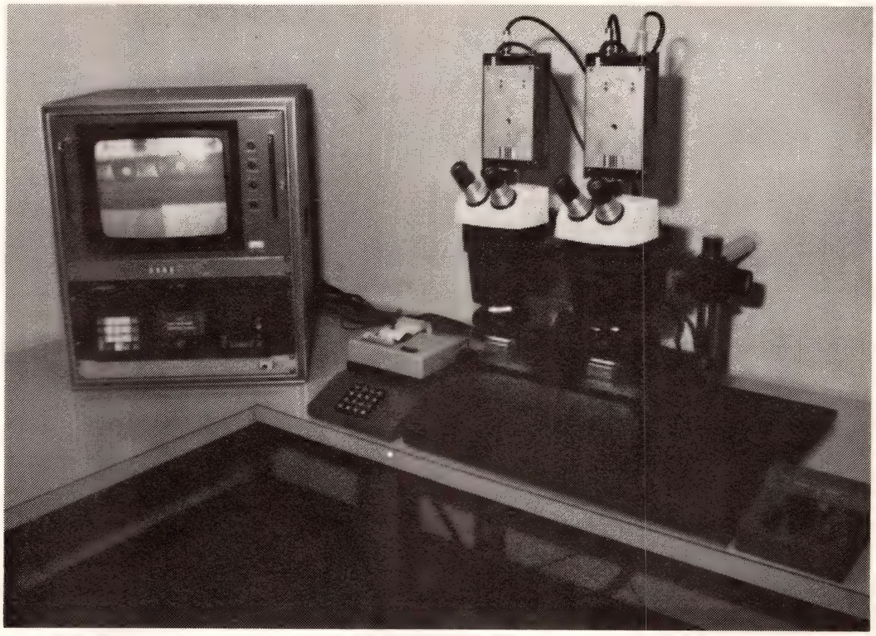
If necessary, the inspector can change from a split-screen to a whole-screen view when a wire bond or chip requires a closer look. Since the amount of magnification may be manually adjusted on the microscopes, the inspector has many ways to view a hybrid.

According to Dan Epstein, Vice President of Product Assurance, "The automated system eliminates the potential for human error." An inspector controls only the rate of sequencing, and even then, only slight adjustments in the machine's overall speed are possible. ■■

Gene Heftman
Field Editor



The automated inspection system provides a split-screen TV-monitor picture. The known good hybrid is on the left; the device to be tested is on the right.



Visual inspection of hybrid circuits is more accurate, faster and less taxing on inspectors who use the automated inspection system developed at ILC Data Device Corp. Its components are a closed-circuit TV system, a computer-controlled x-y table and a keyboard and printer.

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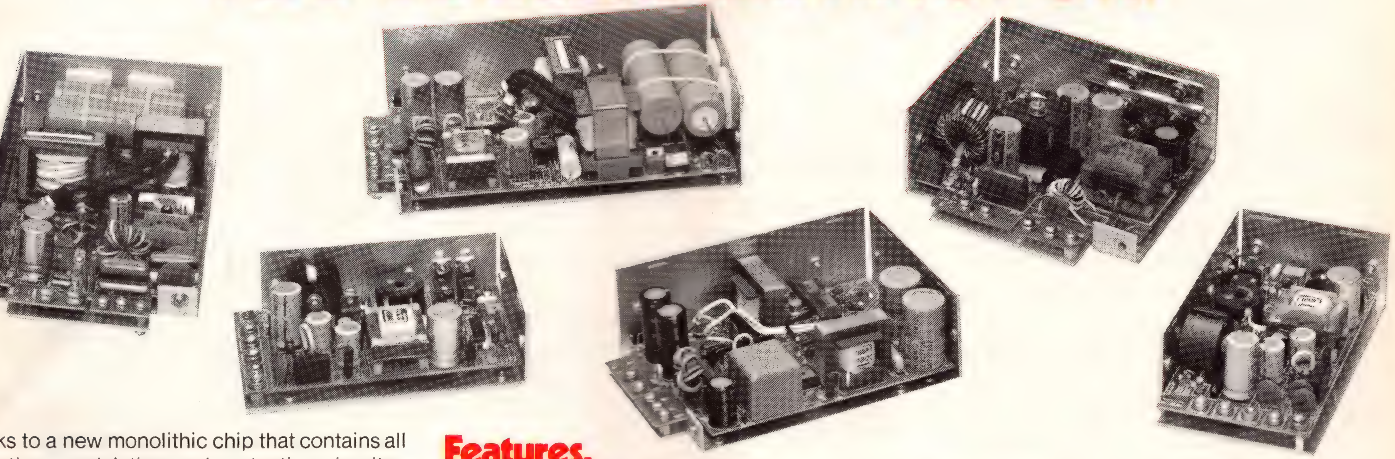

Thanks to a new monolithic chip that contains all regulation, modulation and protective circuitry, Power/Mate now offers top quality switching regulated power supplies at a fraction of the cost of conventional switchers. In many cases even less than the cost of quality linear supplies.

Typical parts count is reduced 20% for a much higher MTBF...well over 50,000 hours...with a two year warranty to back it up. Reliability is greatly improved by use of computer-aided "worst-case analysis," individual testing of every IC and semiconductor, and a comprehensive burn-in program.

The new ES Series boasts well over one watt output per cubic inch, 70-80% efficiency and a 16ms holdup time.

But the big news is dollars per watt, a breakthrough achieved through advanced design and manufacturing techniques. Power/Mate's ES Series switchers set the new standards for value and performance in switching power supplies for years to come.

Features.

- Brownout protection.
- Overvoltage protection.
- Overload protection.
- Short circuit protection.
- Reverse polarity protection.
- Soft start protection.
- Meets UL and CSA standards.
- Convenient 3-surface mounting.
- Convection cooled.
- Remote sensing.
- Optional logic inhibit.
- Advanced EMI filtering.

Specifications.

AC Input. 85-132 and 170-264 VAC, 47-63Hz.

DC Output. See charts.

DC Output Adjustability. ±10%

Regulation. Line ±0.1% + 1mV within AC limits specified above. Load ±0.1% + 1mV from no load to full load

Noise and Ripple. 50mV peak-to-peak max., 20Hz to 200KHz.

Efficiency. 70 to 80%.

Transient Response. Recovery to 1% in 300 microseconds for a 50 to 100% load change.

Remote or Local Sensing. Provision included for improved overall regulation.

Overload and Short Circuit Protection. Solid state short circuit protection. Automatic electronic current limiting circuit limits output current adjustable between 105% and 125% of unit rating, thereby providing protection for the load as well as the supply. Units cannot be damaged by prolonged short circuits.

Overshoot. No voltage spikes on turn-on, turn-off or power failure.

Logic Inhibit Function—Optional. A command signal between 4.5 and 5.5V referenced to (—) negative sense terminal will inhibit the DC ouptut. May be used for control, sequencing or maintenance.

Overvoltage Protection. Built-in, fixed.

Energy Storage Time. The output voltage will remain within regulation for a minimum of 16 milliseconds after loss of AC input power (from nominal line voltage).

Polarity. May be either positive, negative or floating up to 300 volts DC.

Soft Start. Provides input current limiting at turn-on.

Parallel Operation. Units may be paralleled for increased output current. Consult factory.

Long Term Stability. 0.1% for 8 hours after 20 minute warm-up.

Ambient Operating Temperture. Continuous duty from 0°C to 71°C. Full rating from 0°C to 50°C, derate linearly to 60% of rating at 71°C.

Storage Temperature. −55°C to +85°C.

Quality Control. In accordance with MIL-I-45208.

ES-C Series $79. 4.10" x 3.24" x 1.68"

MODEL	VOLTAGE	CURRENT
ES-5C	5 VOLTS	3 AMPS
ES-12C	12 VOLTS	1.5 AMPS
ES-15C	15 VOLTS	1.2 AMPS
ES-24C	24 VOLTS	0.75 AMPS
ES-28C	28 VOLTS	0.65 AMPS
ES-36C	36 VOLTS	0.5 AMPS

ES-D Series $83. 6.12" x 3.24" x 1.75"

MODEL	VOLTAGE	CURRENT
ES-5D	5 VOLTS	6 AMPS
ES-12D	12 VOLTS	3 AMPS
ES-15D	15 VOLTS	2.4 AMPS
ES-24D	24 VOLTS	1.5 AMPS
ES-28D	28 VOLTS	1.3 AMPS
ES-36D	36 VOLTS	1.0 AMPS

ES-E Series $89. 4.62" x 4.88" x 2.00"

MODEL	VOLTAGE	CURRENT
ES-5E	5 VOLTS	10 AMPS
ES-12E	12 VOLTS	5 AMPS
ES-15E	15 VOLTS	4 AMPS
ES-24E	24 VOLTS	2.5 AMPS
ES-28E	28 VOLTS	2 AMPS
ES-36E	36 VOLTS	1.5 AMPS

ES-F Series $149. 7.10" x 4.88" x 2.37"

MODEL	VOLTAGE	CURRENT
ES-5F	5 VOLTS	20 AMPS
ES-12F	12 VOLTS	10 AMPS
ES-15F	15 VOLTS	8 AMPS
ES-24F	24 VOLTS	5 AMPS
ES-28F	28 VOLTS	4 AMPS
ES-36F	36 VOLTS	3 AMPS

ES-G Series $189. 8.60" x 4.88" x 2.37"

MODEL	VOLTAGE	CURRENT
ES-5G	5 VOLTS	30 AMPS
ES-12G	12 VOLTS	15 AMPS
ES-15G	15 VOLTS	12 AMPS
ES-24G	24 VOLTS	8 AMPS
ES-28G	28 VOLTS	7 AMPS
ES-36G	36 VOLTS	5 AMPS

ES-H Series $229. 10.60" x 4.88" x 2.60"

MODEL	VOLTAGE	CURRENT
ES-5H	5 VOLTS	45 AMPS
ES-12H	12 VOLTS	22 AMPS
ES-15H	15 VOLTS	18 AMPS
ES-24H	24 VOLTS	12 AMPS
ES-28H	28 VOLTS	10 AMPS
ES-36H	36 VOLTS	8 AMPS

Options: Crowbar up to 8 Amps $8, greater than 8 Amps $16; Add Suffix V to Model No. Cover $6, Add Suffix C to Model No. Logic Inhibit $8; Add Suffix I.

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CIRCLE NUMBER 17

LCDs, touch switches team up in multimode display panel

LCDs with built-in touch entry switches will inaugurate a new concept for information displays. Arranged in a 6 × 4 element matrix, each LCD/switch combination displays messages in a choice of three viewing modes—positive, negative or outlined image (see picture).

The transmissive display element and other types of dichroic LCDs are under development at General Electric's Corporate R & D Center (Schenectady, NY). GE will present performance details and a working display panel at the International Seminar of the Society for Information Display (San Diego, CA) on April 28 through May 2, 1980.

Multimode displays offer several advantages. Different indications—system status, alarm condition, etc.—can be assigned to a switch on the basis of mode. Colored filters, placed over selected panel areas, can define groups of display elements having common functions. Since an operator actually touches the display/switch to enter data, the system provides unambiguous I/O indications.

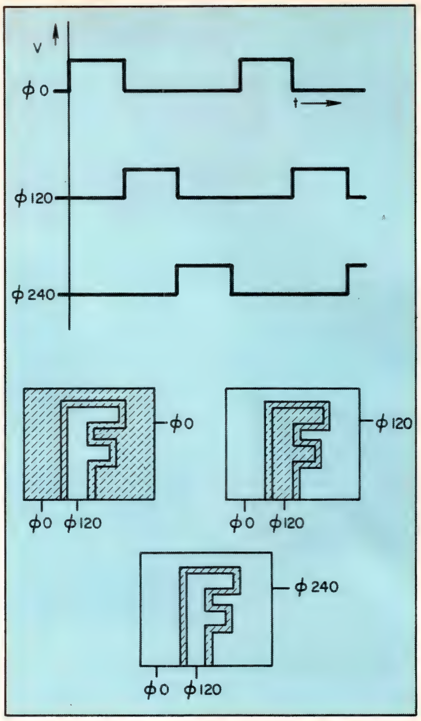
Gene Heftman
Field Editor

The dichroic LCD is fabricated using standard materials and processes. Its multimode operation depends primarily on patterning and voltage excitation of three display electrodes. The symbol-body electrode and the background electrode are energized with two phases of a three-phase square-wave voltage source. Any one of the voltage phases can drive the third (control) electrode, and the display format varies according to which phase is used. Thus, multimode operation is accomplished simply by phase-controlling a single electrode.

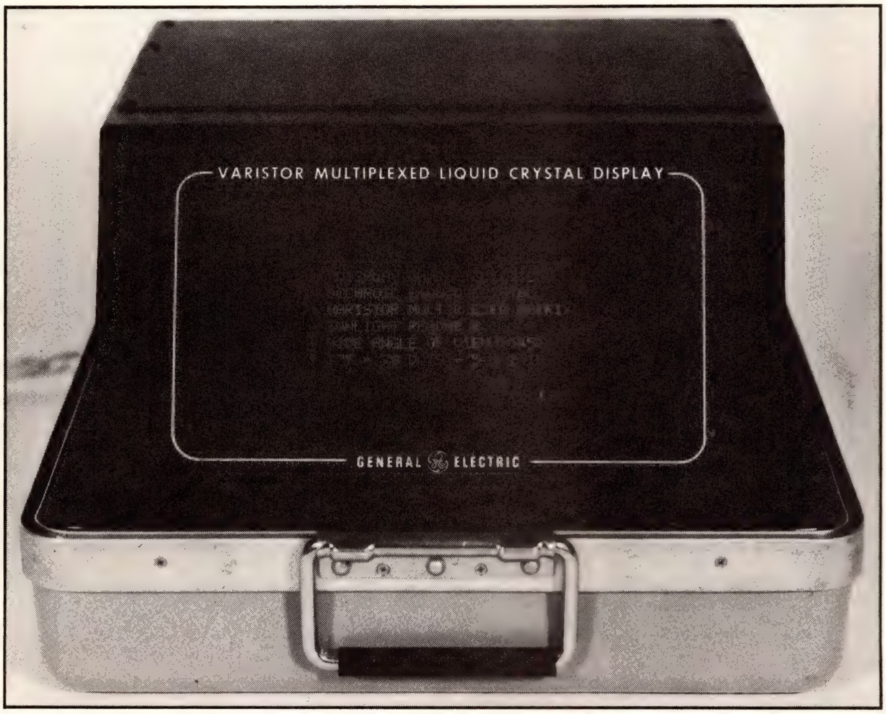
Also under investigation at GE are liquid crystals based on the solution of dichroic dyes as guests in colorless liquid crystal (cholestric) hosts. Such displays do not require polarizers, unlike twisted nematic liquid crystals, but are said to perform better, in terms of brightness and viewing angle.

Another experiment mates a cholestric host with a ZnO varistor to fabricate reflective liquid crystal matrix displays (see photo). The varistor acts as a nonlinear control element in a multiplexed LCD system.

Several advantages are claimed for the varistor technique compared to silicon transistors and thin-film transistor array control elements. The matrices are simple to construct and give improved yield. Display elements are turned on by applying a pulsed voltage of a few μs across the LC element and varistor series pair. A 70 × 175-line matrix display, with a resolution of about 36 lines/in. has already been built.■■



Multimode LCDs are projected in any one of three forms, depending on the method for energizing the display. A three-phase square-wave voltage source provides the drive voltages.



Varistors replace transistors as the nonlinear control devices in this reflective-type, multiplexed liquid crystal display.

Want to go?

The International Seminar and Symposium of the Society for Information Display will be held at the Town and Country Hotel, San Diego, CA, April 28 through May 2. For information on the technical program and special seminars, contact Lewis Winner, 301 Almeria, P.O. Box 343788, Coral Gables, FL 33134; (305) 446-8193.

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Male connectors with 90-degree pc terminals; female with either wire-wrap or pc terminals.

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0619-2-0103

CIRCLE NUMBER 181

Electronic Design
INTERNATIONAL

April 12, 1980

Synthesized generator does high-frequency tests

4½-digit multimeter measures true rms

Low-cost frequency counter goes beyond 100 MHz

Function generator produces high outputs

SIEMENS

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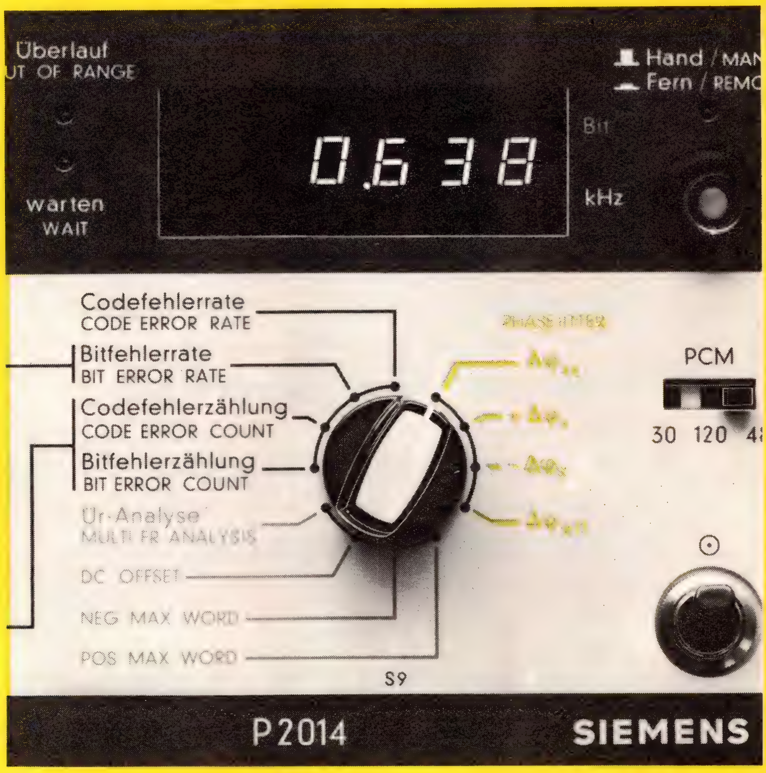
May 19-23, 1980
Rio de Janeiro, Brazil

PCM System Analyzer with Phase Jitter Meter



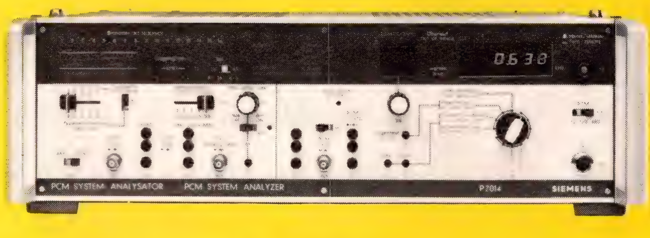
The P2014 system analyzer by Siemens can measure all major parameters on PCM systems with 30, 120 or 480 channels.

As well as analyzing PCM 30 signals, the P2014 can also measure characteristics at digital interfaces. This includes detecting and counting bit errors and code violations and determining bit and code error rates in the range up to 34 Mbit/s using various test patterns.

Bit errors may be caused not only by defective regeneration of the PCM signal but also by imperfect equalization as a result of phase jitter in the regenerative repeaters.

The meter contained in the P2014 measures phase jitter both in the PCM system and individual components. The result is automatically displayed in bits.

Further information on this PCM system analyzer can be obtained from the specialist advisers at Siemens regional offices or direct from Siemens AG, Nachrichtenmessgeräte, Postfach 70 00 79, D-8000 München 70.

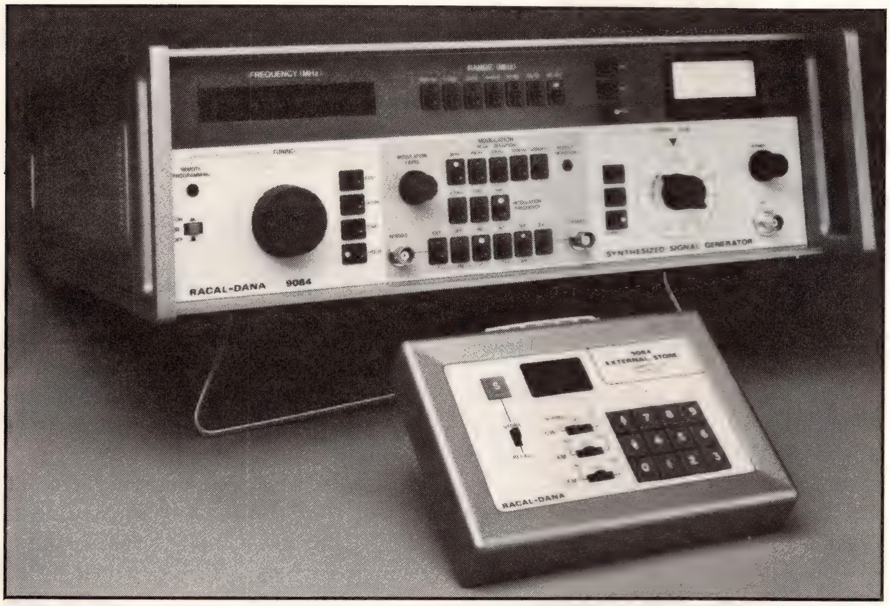


Siemens PCM system analyzer for 2 Mbit/s, 8 Mbit/s and 34 Mbit/s

CIRCLE NUMBER 183

N 282/8003.101

Fully synthesized generator conducts hf tests



Racal-Dana Instruments Ltd., Duke St., Windsor, Berkshire SL4 1SB, England. (07535) 69811. Telex: 847013.

A fully synthesized signal generator is the first, according to Racal-Dana, to meet the stringent demands of high-frequency communications. With a range of 10 kHz to 104 MHz, the 9084 covers the entire hf radio band, as well as the specialized low-frequency and low-band vhf regions.

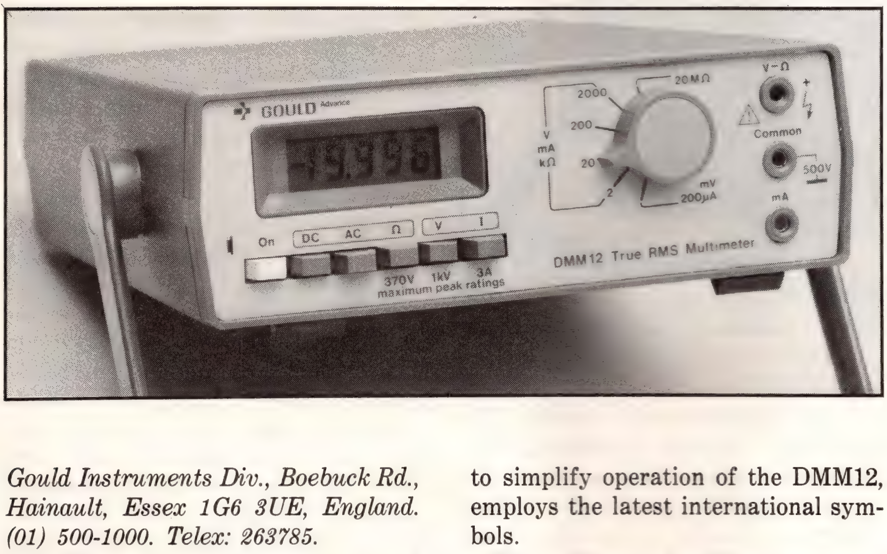
The instrument features excellent stability and spectral purity, exceptionally low-noise and rf interference, comprehensive modulation capabilities, precision frequency setting, simplicity of operation, programmability and a wide range of output voltages. It meets MIL-T-28800 and IEC specifications.

The built-in frequency standard of the 9084 ensures a frequency stability of 5 parts in 10^{10} per day. Harmonics are normally 40 dB below the carrier level, with no subharmonics. A patented Racal transfer-loop system guarantees a typical signal-to-noise ratio of 140 dB at 1 to 100 MHz, for noise components that are 20 kHz or more from the carrier. Careful design and specialized shielding material eliminate carrier leakage, so that even the most sensitive communications receivers are unaffected by RFI.

The wide output range of the 9084 is continuously variable from 0.07 μV to 2 V rms into a 50-Ω load. Output level is indicated on a front-panel meter. Frequency selection is by a patented spinwheel encoder that covers the full frequency range in seven bands, with a maximum resolution of 1 Hz. A hold position electronically disables the spinwheel and locks the output frequency at its last setting.

CIRCLE NO. 501

Accurate digital multimeter measures true rms



Gould Instruments Div., Boebuck Rd., Hainault, Essex 1G6 3UE, England. (01) 500-1000. Telex: 263785.

A 4½-digit multimeter, the Gould DMM12 makes true-rms measurements on ac signals, with an accuracy of 0.05%. Readings are shown on a liquid-crystal display. The front panel, which is economically designed to simplify operation of the DMM12, employs the latest international symbols.

The multimeter has 27 measurement ranges for ac and dc voltage, current and resistance. Optional probes measure radio frequency and high voltages. The maximum resolution for voltage measurements is 10 μV; for current, 10 nA, and for resistance, 100 mΩ.

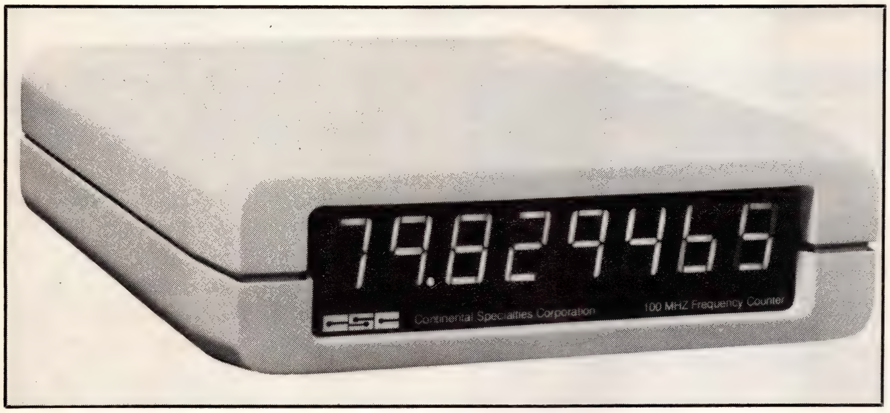
A built-in circuit provides true-rms ac/dc conversion. The converter accepts waveforms with a crest factor (peak-to-rms ratio) of up to 4:1 at full scale. A combined ac/dc facility allows measurement of ac waveforms with a dc content. Because the true-rms value shows the energy content of a waveform, the DMM12 is well suited to power system measurement.

The maximum reading on the liquid-crystal display is 19999. The display incorporates separate positive or negative polarity indication, plus a decimal point. Overrange and "battery low" are also indicated.

The DMM12 is housed in a rugged case and meets IEC348 and VDE specifications. Standard models are ac-line powered, but option BP12 gives portability with rechargeable cells. The instrument carries a two-year guarantee.

CIRCLE NO. 502

Low-cost frequency counter handles 100 MHz


79.829465
CSC
Continental Specialties Corporation
100 MHZ Frequency Counter

Continental Specialties Corporation (U.K.) Ltd., Shire Hill Industrial Estate, Saffron Walden, Essex CB11 3AQ, England. (0799) 21682. Telex: 817477

For just £77.55 (plus V.A.T.), the portable MAX-100 frequency counter from Continental Specialties measures frequencies to 100 MHz—and, for just £35 more, to 500 MHz by using a PS-500 prescaler.

What's more, a wide range of accessories and power-supply options adapt the MAX-100 input to both laboratory and field applications.

Continuous reading is guaranteed from 20 Hz to 100 MHz. In addition, the MAX-100's crystal-controlled time base is accurate to three parts in 10^6, and a sensitive preamplifier allows measurements to be made with signals as low as 30 mV. Diode protection limits the peak input to 200 V.

Readings are displayed on an eight-digit LED readout with characters 0.6 in. high. The extreme left-hand digit flashes automatically when the input frequency exceeds 100 MHz. To make readings, the counter automatically samples the input for 1 second, with updates every 1-1/6 s.

In addition to the prescaler, there are various accessories that adapt the input for specific applications. A clip-lead input cable is supplied with the counter. An optional low-loss in-line cable tap allows use with uhf connectors. And an optional "mini-whip" antenna is available for use where direct coupling is not feasible.

Users can choose from four different power sources. The basic instrument, while powered by an internal battery, could alternatively be powered by ac lines (110 or 200 V), by a mobile 12-V dc supply, or by an external dc supply. Battery chargers are available.

CIRCLE NO. 503

'Sweeping' function generator delivers high outputs

N.V. Philips Gloeilampenfabrieken, Science and Industry Div., P.O. Box 523, 5600 AM Eindhoven, The Netherlands. (040) 783455. Telex: 51573.

An inexpensive function generator, the PM5132, does more than offer a choice of sine, triangular or square waves and positive or negative pulses. It also provides an output of 30 V pk-pk for continuous waveforms or 15 V pk-pk for pulses. What's more, many adjustable sweep features are included.

Total frequency range spans 0.1 Hz to 2 MHz, in seven overlapping frequency subranges. Frequency setting is linear, and the dial allows a setting accuracy of ±2% of the maximum subrange frequency. A vernier allows frequency adjustments of ±5%.

Moreover, the output duty cycle can be adjusted from 10 to 90%, and the output attenuation up to 80 dB—either continuously or in steps. Adjustable dc offset from −10 to +10 V is provided for all functions. In addition, internal and external linear sweeps are not only standard but also adjustable up to 2½ decades. And sweep time is continuously adjustable from 50 ms to 100 s.

Sweeps can be made either continuously or singly, with a maximum frequency of around 15 kHz. In addition, the start frequency for the sweep can be shifted to any point in the chosen subrange, with the setting independent of the chosen stop frequency.

A TTL output is synchronized with the output function, which has a fixed level and the same duty cycle as the minimum output. Switch-output impedances allow matched operation with 50 or 600-Ω loads, with outputs protected against short circuits.

Simple pushbutton operation allows the PM5132 to be used by professional and unskilled operator alike. Moreover, minimal bench space is needed thanks to the instrument's compact dimensions of 140 × 210 × 330 mm. With a power consumption of 25 W, it operates from 110, 128, 220 or 238 V ±10%, from 50 to 100 Hz.

CIRCLE NO. 504

contraves

The new trend: LED-Line by Contraves, the solid state analog display

Today, there is hardly a real alternative to LED components. This applies to analog displays as well. That's why we developed the LED-Line.

These compact panel units feature bright displays with numerous advantages.

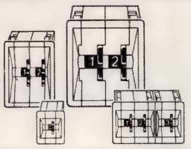
Whether you want to display or observe monitoring or tuning operations, one glance is enough to see the results, even several results simultaneously. The units are compact, mount horizontally or vertically, and can be read in darkness, too. Whether your input is analog or digital, LED-Line *is ready for wiring. That's the new trend.*

Some technical data:

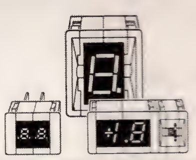
- *21 and 51 light points*
- *Resolution up to 2%*
- *Bar or floating dot display, even selectable*
- *Zero point offset*
- *Measures positive and negative input voltages*
- *High input impedance*
- ***Analog:** input sensitivity 100 mV FS*
- ***Digital:** up to 6 bit binary, TTL*

Choose from a line of 14 standard types off the shelf. Send for our brochure.

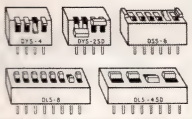
Further Contraves products



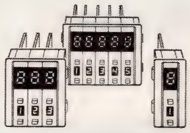
Contraves Multiswitch, *thumbwheel switches*



Contraves Codicount, *7-segment LED displays*



Contraves DIP-Switch, *dual in-line switches*



Contraves Multicount, *switch/display modules*

contraves

Contraves AG, Schaffhauserstrasse 580, Postfach, CH-8052 Zürich, Telefon 01/306 22 11
Contraves Industrial, Products Ltd., Times House,
GB-Ruislip/Mddx HA4 8LH, Telefon (08956) 30 196

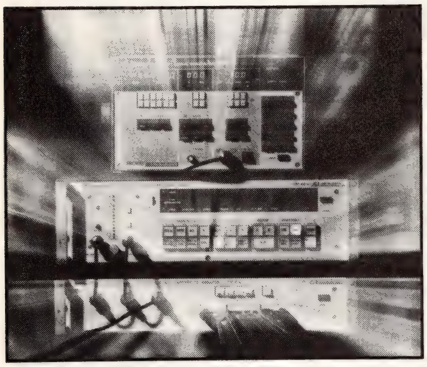
Subsidiaries: Germany: Contraves GmbH, D-8013 Haar/München, Italy: Prodotti Industriali Contraves S.r.l., I-20 133 Milano, Japan: K. K. Codix, 1-9-15 Kaigan, Minato-ku, J-Tokyo

MA/3/80

CIRCLE NUMBER 184

International New Products

Test adapter lets you measure s-parameters

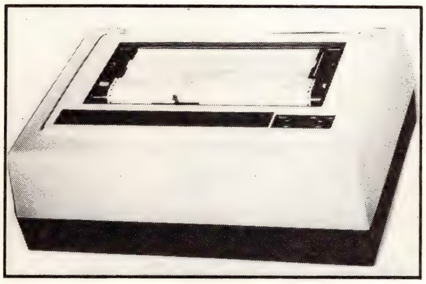


Rohde & Schwarz GmbH, Pressestelle, Mühldorfstrasse 15, Postfach 801469, D-8000, München 80, Federal Republic of Germany. (089) 41292625. Telex: 523703.

A test adapter, ZPV-Z5, operates with the Rohde & Schwarz ZPV vector analyzer to allow convenient measurement of all s-parameters of a two-port network at frequencies from 5 MHz to 2 GHz. The adpater avoids troublesome modification of the instrument and time-consuming recalibration. A built-in IEC-bus interface allows the tests to be controlled by a suitable desk-top calculator. Because of the instrument's built-in VSWR bridges, tiny reflection coefficients can be accurately measured. Programming of the test adapter is included in the basic software and in the special software for accuracy improvement.

CIRCLE NO. 505

Color matrix printer produces CRT copies

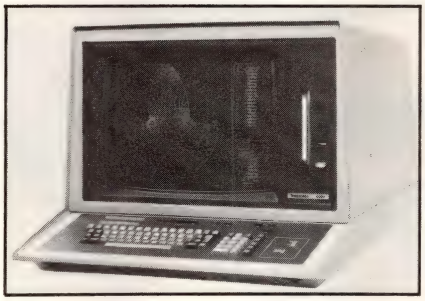


Integrex Ltd., Portwood Industrial Estate Church Gresley, Burton on Trent, Staffordshire DE11 9PT, England. Burton on Trent (0283) 215432. Telex: 377106.

Model 454C, serial matrix printer, has three-color capability and is intended to provide hard copy of color CRT displays. The microprocessor-controlled bidirectional unit prints 250 characters per second with a single print head on a 9 × 9 matrix. Maximum line length is 155 characters. The standard character font is to ECMA-42. Custom character fonts are available. Vertical shifting of the three-color striped ribbon ensures maximum throughput. The printhead is momentarily retracted during color shift. Ribbons are available in most color combinations. Available interfaces include IEEE488 and various serial and parallel versions.

CIRCLE NO. 506

Desktop computer gets dynamic graphics option



Tektronix U.K. Ltd., Beaverton House, P.O. Box 69, Harpenden, Hertfordshire, England. Harpenden 63141. Telex: 25559.

The Tektronix 4054 desktop graphics computer now comes with Option 30 to provide dynamic graphics capability. This adds greater interactivity to the existing capability of the 4054. It allows the user to work directly with the elements of a design project. Using simple Basic language commands, the option allows the user to create and manipulate complex graphics objects with considerable speed and simplicity.

CIRCLE NO. 507

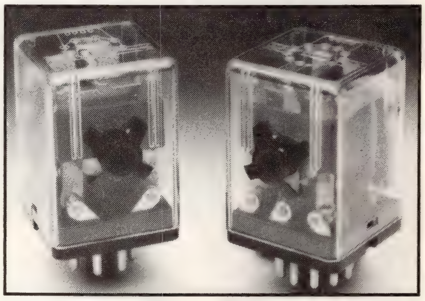
Dual-photodiode array acts as position sensor

Laser-Optronic, Avenue de Broqueville 222, Boite 6, B-1200 Bruxelles, Belgium. (02) 771-2166. Telex: 61439.

A monolithic dual photodetector, LD2-0, detects minute movements of a spot of light centered on the two photodiodes. The monolithic structure allows an extremely close spacing of just 0.05 mm between the diodes, matching of the responsivities to better than 5% and good spatial uniformity of response across the active areas. Diode dimensions are 2 × 0.5 mm. Responsivity is 0.5 A/W at 900 nm. Response is optimized for light wavelengths from 450 to 1060 nm. Rise time is 100 ns with a reverse bias of 20 V.

CIRCLE NO. 508

Plug-in relays allow push-button actuation

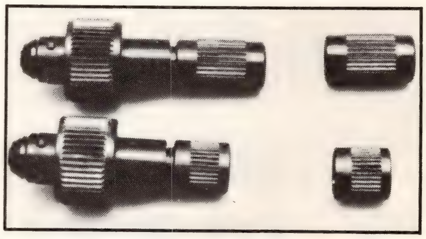


Pye Electro-Devices Ltd., Exning Road, Newmarket, Suffolk CB8 OAX, England. (0638) 5161. Telex: 81245

Octal-based relays in Pye's Series 12 now incorporate push buttons so that they can be actuated manually without applying a coil voltage. Operating sequences can be manually shortened or interrupted for fault analysis. Relays in the new series are general-purpose, two or three-pole, change-over types for ac or dc operation. Contact ratings up to 10 A are available, with a choice of contact materials. Options include models for tropical environments and versions with neon indicators to show when coils are energized. The rugged and compact units have molded multipin bases and clear polycarbonate covers.

CIRCLE NO. 509

Fiber-optic connectors suit graded-index fibers



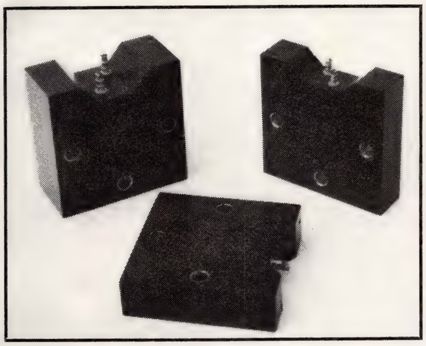
Hellerman Deutsch Ltd., Imberhorne Way, East Grinstead, West Sussex RH19 1RW, England. East Grinstead (0342) 21231. Telex: 95118.

A connector system from Hellerman

Deutsch terminates and interconnects graded-index, single fiber cables. The system includes a connector plug, a receptacle/lens assembly, emitters and detectors and a fiber-breaking tool. Plugs can be installed easily and quickly onto the fiber with no special skills. Results are repeatable and insertion loss is less than 1 dB.

CIRCLE NO. 510

Rugged modules contain wet tantalum capacitors

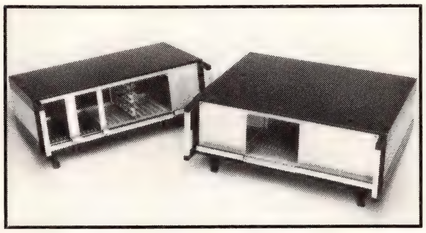


Sprague World Trade Corp., 3 Chemin de Tavernay, 1218 Geneva, Switzerland. (022) 984021.

Type 240D Tantapak modules are a packaging development of Sprague's well established wet tantalum capacitors, types 709D, 737D and 738D. The capacitors are mounted on a printed-circuit board and then epoxy encapsulated in a rugged flame-retardant module. Two case sizes are currently available. All components are manufactured to BS9073 and the modules may be released to DEF STAN 05-21 or DQAB requirements.

CIRCLE NO. 511

Instrument case frame extends sub-rack system

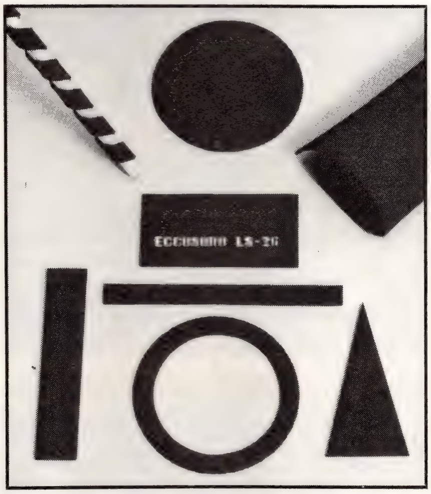


Vero Electronics Ltd., Industrial Estate, Chandler's Ford, Eastleigh, Hampshire S05 3ZR, England. (04215) 69911

The KM6 case frame extends Vero's KM6 sub-rack system. The system provides packaging designers with flexibility. Modules and plug-in units are interchangeable among different manufacturers' card-frame systems because the system conforms to DIN-41494 and IEC-48D draft specifications. The free-standing instrument case accepts individual guides on a 5.08-mm pitch. With guides in position, the case frame accepts plug-in modules and cards from the Vero KM6 sub-rack system.

CIRCLE NO. 512

Flexible foam sheet absorbs rf energy

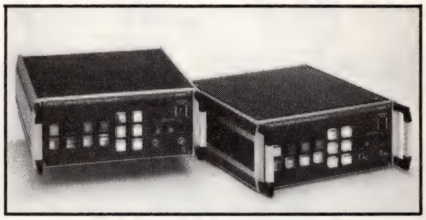


Emerson & Cuming (U.K.) Ltd., Colville Rd., Acton, London W3, England. (01) 992-6692.

A series of high-loss, flexible, foam-sheet materials, Eccosorb LS, has a density of about 5 lb/ft^3 (0.08 g/cc). The materials absorb electromagnetic energy in a variety of applications. The foam sheet can be used to line the interior of a cavity to lower its Q; to wrap around a radiating element to eliminate surface currents; or it can be cut into wedges or tapered pieces and used inside waveguides as dissipative material. Electrical characteristics are uniform throughout each sheet of material. Standard sheet size is 24 × 24 in. (61 × 61 cm). Thicknesses of 0.125 in. (0.3 cm), 0.25 in. (0.6 cm) and 0.375 in. are available. Sheets can be cemented in layers to increase thickness. The materials are available in a wide range of dielectric properties —characterized by insertion loss and dielectric loss factor.

CIRCLE NO. 513

Color-pattern generators aim at SECAM systems



N.V. Philips Gloeilampenfabrieken, Scientific and Industries Div., P.O. Box 523, 5600 AM Eindhoven, The Netherlands. (040) 783455. Telex: 51573.

Two color-pattern generators, PM 5215-SECAM and PM 5217-SECAM/PAL, meet the requirements of various SECAM TV systems now in use. Both instruments offer a wide choice of test patterns. Their crystal-controlled rf outputs and their versatility make these instruments ideal tools for accurate video measurements in the professional field, as well as in production and quality control. Both can be equipped with from one to four different rf crystal oscillators. A ten-position selector allows use of the same rf channel for TV systems with differing sound/vision spacing.

CIRCLE NO. 514

Bench-top system produces PC boards

Mega Electronics Ltd., 9 Radwinter Rd., Saffron Walden, Essex CB11 3HU, England. Saffron Walden (0799) 21918.

A self-contained production system, BT-3007, makes printed-circuit boards in sizes up to 10 × 12 in. The bench-top system includes five processing tanks, of 5-liter capacity, housed in a single free-standing enclosure. Complete PC production times of under 15 min are claimed for the system. The tanks—for developing, washing, etching, washing and tinning—are made of impact-resistant ABS. Safety features offer safeguards against spillage and damage during operation. Hinged lids protect the user from splashing. The BT-3007 measures 40 × 24 × 31 in. It is supplied ready for connection and operation at a price of £405 plus VAT. A recirculation system is available for an additional £140.

CIRCLE NO. 515

Only you can analyse data . . . all a logic analyser can do is to capture and display data in the most versatile and convenient way for you to carry out that analysis.

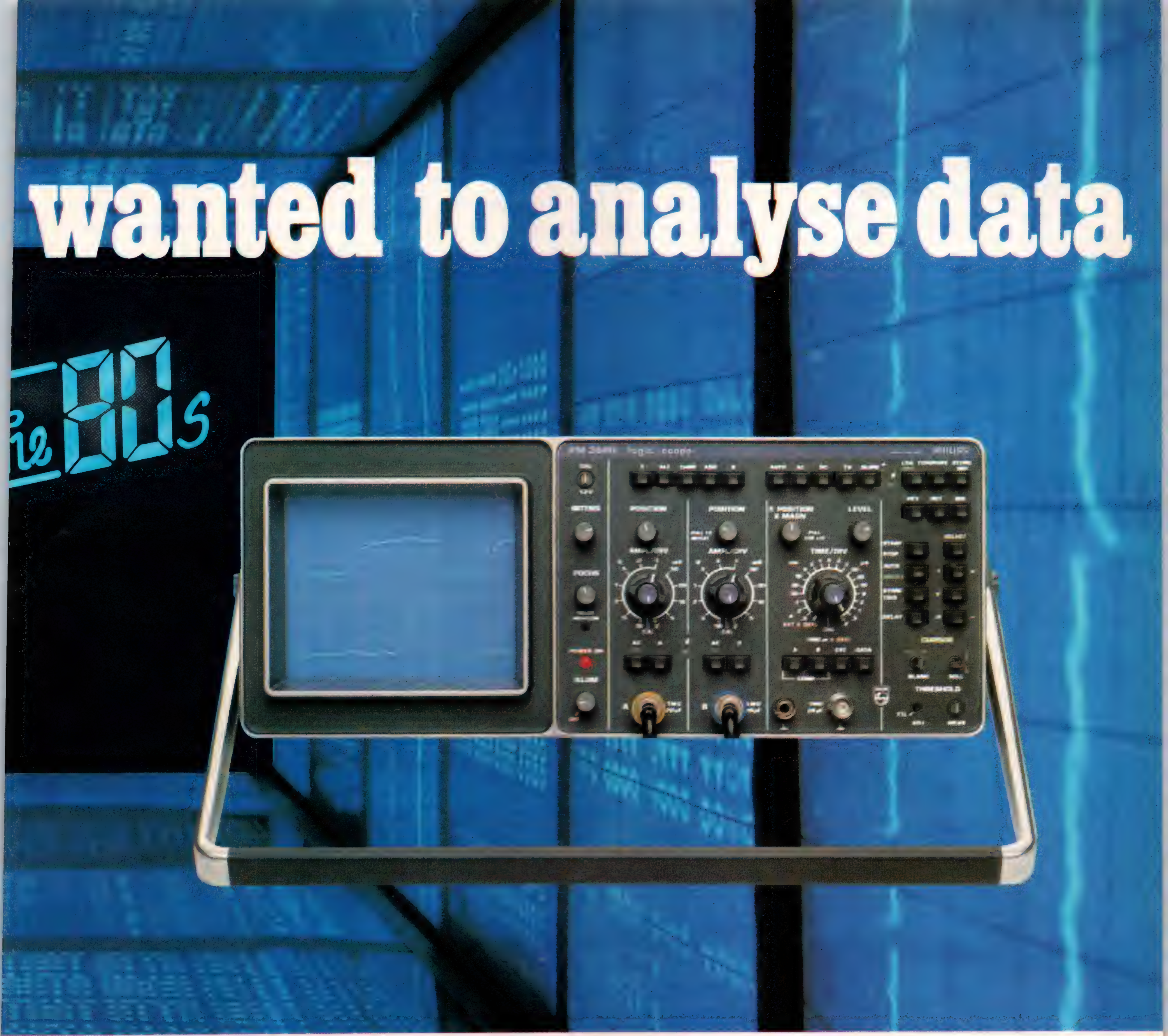
In order to do that, a logic analyser must be capable of showing you, immediately, the relationship between software and hardware. This is a fundamental requirement. On Philips' instruments the transition between digital and analog worlds . . . from state to timing and back . . . is made at the touch of a button, providing the instantaneous relationship needed for fault location and analysis.

Another very important need in logic analysis is ease of operation, since the analysis is usually complex enough, without having to spend time working out how to handle the instrument. Again with Philips this need has been studied in depth.

Ease of operation starts with the dedicated logic probes that feature a micro-miniature design and a host of user benefits. It continues on the front panel, with logical controls that

Feature summary: PM 3500
- ☐ logic state/timing analyser
- ☐ 100 MHz clock rate
- ☐ 16 channels
- ☐ 504 x 16 memory
- ☐ 3ns glitch catching
- ☐ trigger extension facilities
- ☐ display modes: binary, octal, hexadecimal, mapping, timing
- ☐ compare facilities
- ☐ handles all logic families
- ☐ comprehensive diagnostic routines

PHILIPS **Test & Measuring Instruments**



Feature summary: PM 3540

- ☐ state analyser/oscilloscope
- ☐ 10 MHz clock rate; 35 MHz bandwidth (2mV sensitivity)
- ☐ 16 data channels; 2 real-time channels
- ☐ 64 x 16 memory
- ☐ 3 clock qualifiers
- ☐ trigger extension facilities
- ☐ display modes: binary, octal, hexadecimal, real time
- ☐ compare mode facilities
- ☐ built-in test routines

give you direct access to all functions. In addition there are the advanced operator features, like smooth and continuous shifting of the captured data block, from a single control, on the PM 3500 and touch button paging through the entire data stream on the PM 3540. Finally, ease of operation ends on the screen, with versatile displays of digital and analog data to match your individual analysis requirement.

Space limitations preclude going into detail on other important points like sampling rate, memory depth and glitch catching. To capture and analyse that data you must send for the brochures.

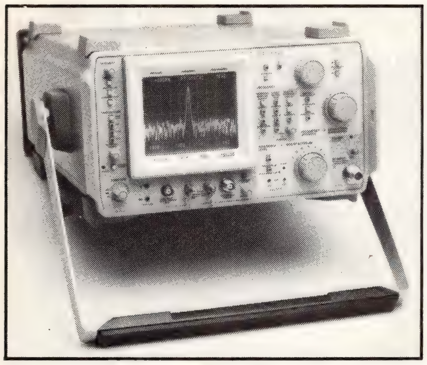
Philips Industries
Test and Measuring Instruments
Dept., TQ III-2-15,
Eindhoven, The Netherlands.

PHILIPS

CIRCLE NUMBER 185

International New Products

Spectrum analyzer reaches out to 60 GHz

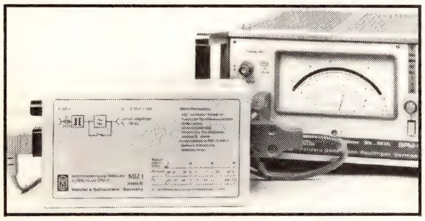


Tektronix U.K. Ltd., Beaverton House, P.O. Box 69, Harpenden, Hertfordshire, England. Harpenden 63141. Telex: 25559.

A portable spectrum analyzer, Model 492, covers a range of 50 kHz to 60 GHz and features an internal microprocessor-based digital control system which simplifies instrument use. Phase-lock stabilization and a resolution of 100 Hz permits precise signal analysis. The instrument's dynamic range of 80 dB allows analysis of low-level signals. Relevant parameters are displayed directly in alphanumeric form on the CRT. Parameters displayed include all major control settings such as reference level, frequency, vertical display, frequency span, frequency range, resolution, bandwidth and rf attenuation. The portable instrument weighs 18 kg and measures 175 × 327 × 500 mm. A rugged case offers environmental protection to the MIL-T-28800G standard.

CIRCLE NO. 516

Attachment for voltmeter measures line harmonics

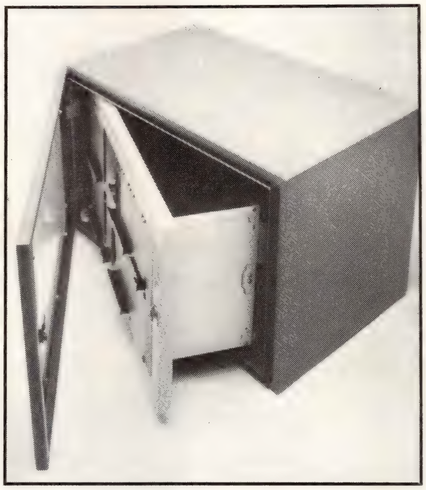


Wandel & Goltermann GmbH & Co., Dept. VW, Postfach 45, D-7412 Eningen U.A., Federal Republic of Germany. (07121) 8911. Telex: 0729833.

The NOZ-1 harmonic measuring attachment provides a simple technique for measuring interference on ac power lines to conform with DIN and VDE regulations. The attachment works in conjunction with the manufacturer's level measuring sets, type SPM-11 or PMG-13. Wandel & Goltermann also offers a free application note, which explains how to make the measurements and which includes conversion tables to derive results in the required units.

CIRCLE NO. 517

Wall-mounting enclosure seals out the environment



Vero Electronics Ltd., Industrial Estate, Chandler's Ford, Eastleigh, Hampshire S05 3ZR, England. (04215) 69911.

A wall-mounting, fully-sealed enclosure offers environmental protection conforming to the IEC-144 IP55 international standard. The enclosure protects equipment—housed in 19-in. card frames or subracks—from severe environmental hazards. It comes in four versions: with or without a swing frame, and with a metal or transparent door. The swing-out frame will house any 19-in. card frame with a height of 3U or 6U. Also, it will house subracks with end-plate depths not exceeding 240 mm.

CIRCLE NO. 518

Timer works for an hour after being unplugged

Tempatron Ltd., 6 Portman Road, Reading, Berks., England. Reading (0734) 583033.

The TDD timer continues to operate for up to an hour after it is unplugged from its power source. In the absence of external power, the timer's internal CMOS circuitry is powered by a charge on its built-in capacitor. The timer should prove valuable in industrial process-control systems, in which short-term loss of power could otherwise be disruptive or damaging. When the supply voltage is applied to the TDD, the timer's internal relay energizes and latches. Should the supply subsequently be removed (due to failure or switch-off), the TDD begins to time but the relay remains closed. Only at the end of the preset time period (up to 1 h) will the relay unlatch.

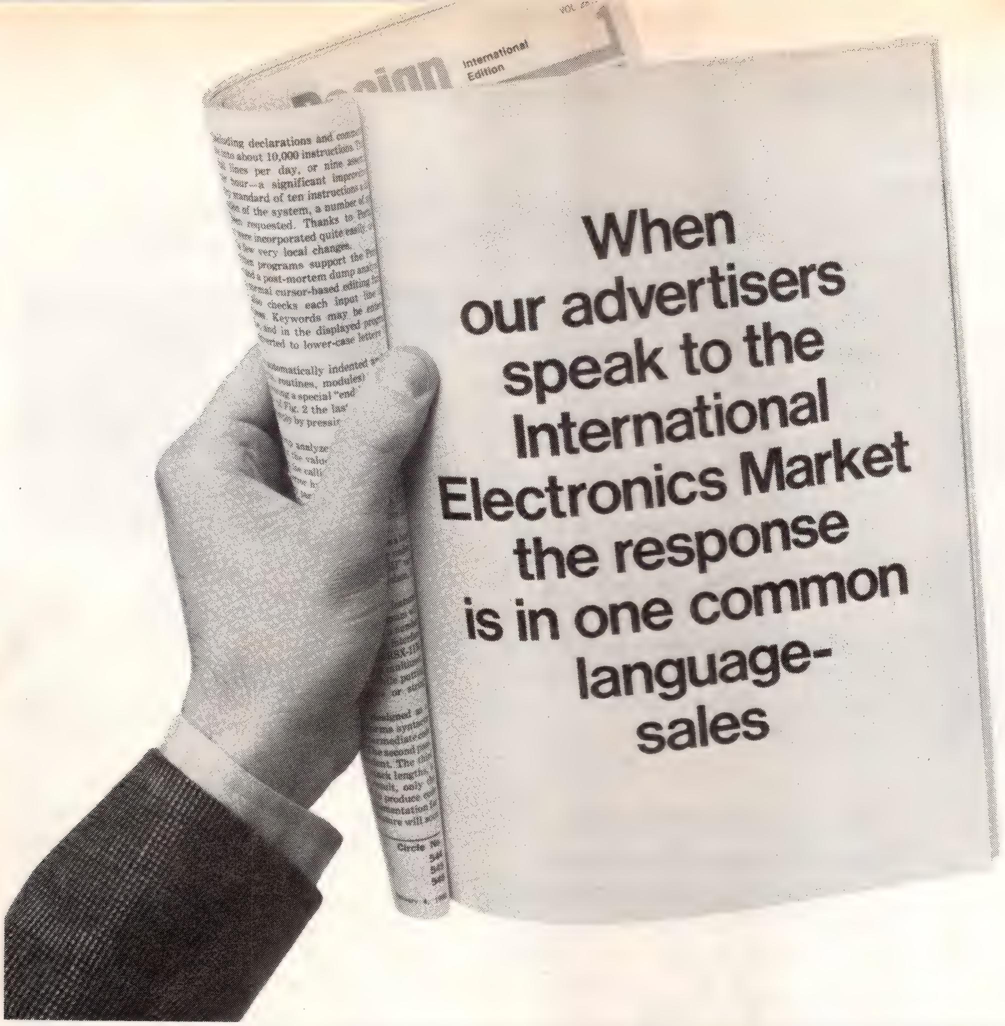
CIRCLE NO. 519

Portable instrument tests data-comm systems

Tektronix U.K. Ltd., Beaverton House, P.O. Box 69, Harpenden, Hertfordshire, England. Harperden 63141. Telex: 25559.

Model-833, second in the Tektronix line of test instruments for data-communications systems, has all the attributes of the earlier Model 832, plus a number of important new features. The 833 has the added ability to perform bit-error-rate tests and block-error-rate tests in accordance with industry standards. Also, it can monitor HDLC/NRZI data transmissions. Like the 832, it can calculate error-detection codes and features a current-loop adapter. Both the old and new instruments are totally self-contained in compact and lightweight carrying cases. The keyboard control system is designed for easy use by service technicians who need not be specialists in data communications.

CIRCLE NO. 520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Phone: (201) 843-0550; TWX: 710-990-5071

TOKYO
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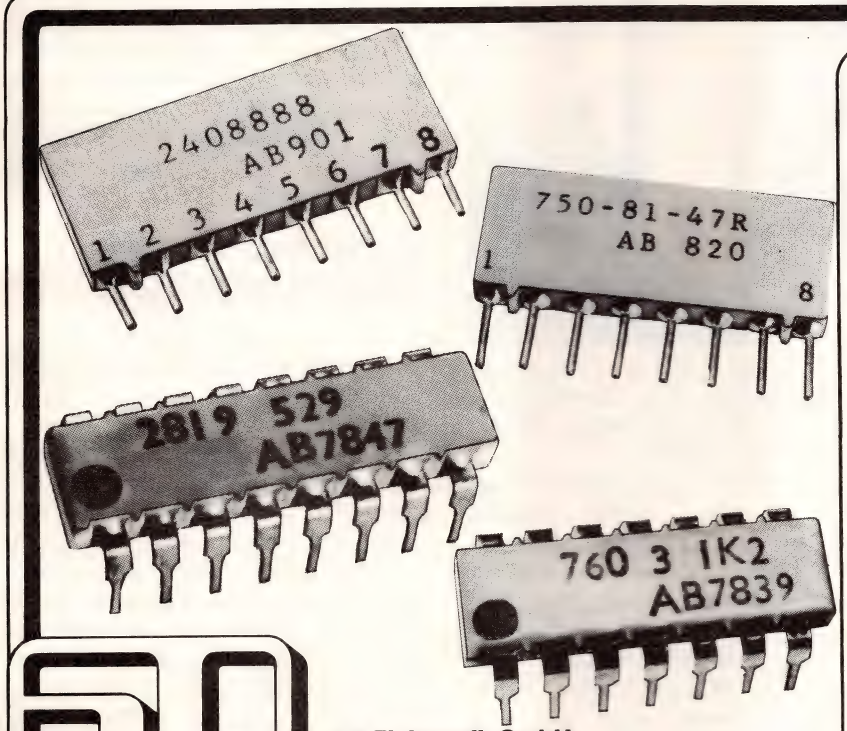
5th Floor, Lila Bldg., 4-9-8 Roppongi
Minato-ku, Tokyo, Japan; Phone: 402-4556
Cable: EMSINCPERIOD. Tokyo

Electronic Design



Resistor Networks Series 760 DIL Series 750 and 850 SIL

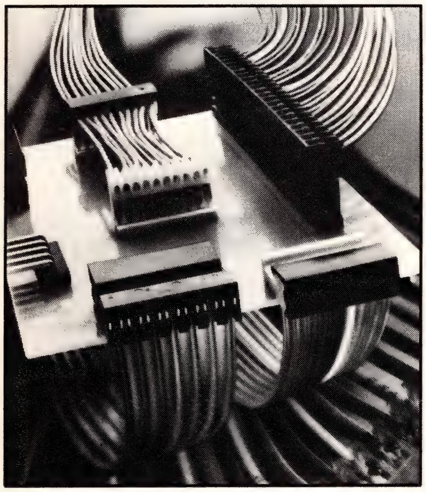
- ✱ Standard: 47 Ohms to 220K Ohms, Series E12 ± 2%
- ✱ Special: 10 Ohms to 10M Ohms.
- ✱ Custom Design: according to customer specification R–networks ± 1% hybrids, active and passive
- ✱ Pitch: 2.54mm measured from centre of pins
- ✱ Fit for automatic handling, mechanically stable
- ✱ Working temperature: –63°C to +150°C
- ✱ Temperature co-efficient ± 250ppm/°C

AB Elektronik GmbH.,
Maria-Birnbaum
Strasse 10a,
8000 Munich 21, Germany.
Tel: 089 573077/78

CIRCLE NUMBER 186

International New Products

Mass cable termination reduces labor costs



AMP of Great Britain Ltd., Terminal House, Stanmore, HA7 4RS, England. (01) 954-2356.

Advantages claimed for AMP's mass termination assemblies (MTA) include lower connecting forces, simplified application, increased productivity and reduced labor costs. The PC-board interconnection systems use an insulation displacement technique for wire termination. Unstripped wire is forced into a slot narrower than its own diameter, and the result is a gas-tight joint using a fraction of the force needed for a conventional crimp. The assemblies will accept discrete wires, ribbon cable or jacketed flat cable. AMP currently offers two systems, MTA 100 and MTA 156, with pitches of 0.100 and 0.156 in., respectively. MTA 100 uses 0.25-in. square posts with housings for 2 to 28 wires. MTA 156 uses 0.045-in., round or square, posts with housings for 2 to 24 wires. Housings are of flame-retardant thermoplastic and are color coded to allow easy identification of wire sizes.

CIRCLE NO. 521

Micro-based system does data acquisition/control

Burr-Brown International Ltd., Cassiobury House, 11-19 Station Rd., Watford, Hertfordshire WD1 1EA, England. Watford (0923) 33837. Telex: 922481

The CS-450 system provides programmable data acquisition and control. Based on a microcomputer, the general-purpose system has a wide range of potential applications—all of which involve capturing data and processing it in real time. Included in the system are a keyboard, a display, the CPU, 32 kbytes of RAM and mass-storage facilities. Also included are special interfaces, a real-time clock/calendar and special software to tailor the system for a specific application. A range of options includes additional RAM, dual tape-cassette drives, a 40-column printer, and a wide choice of analog I/O and isolated digital I/O boards. Available software for the CS-450 includes a number of special-purpose routines (such as peripheral drivers) and a version of extended Basic, modified by Burr-Brown to suit the requirements of the system.

CIRCLE NO. 522

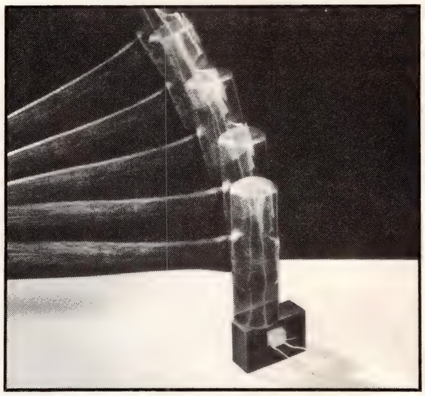
Two-channel recorder has advanced features

Ormed Engineering Ltd., 32 Hydeway, Welwyn Garden City, Hertfordshire AL7 3AW, England. Welwyn Garden 24146. Telex: 299327.

An entirely new two-channel direct writing recorder, MX216, replaces Lectromed's earlier MX215 recorder. The MX216 features a number of advances, including a servo pen drive with a patented rectilinear writing system, an instant electronic speed change, crystal-controlled paper speeds, solid-state event and time markers and built-in general-purpose differential preamplifiers. The new recorder is fully compatible with the existing range of Lectromed external preamplifiers.

CIRCLE NO. 523

Epoxy resin provides good impact resistance



Emerson & Cuming (U.K.) Ltd., Colville Rd., Acton, London W3, England. (01) 992-6692.

A one-component filled epoxy resin system, Stycast 1426, offers extremely high impact strength. Other advantages include medium viscosity and short cure cycles at a relatively low elevated temperature of 175 F (79 C). Because of its impact resistance, Sycast 1426 is expected to find wide use in heavy industrial machinery where severe mechanical shock is prevalent. The hardness of the cured resin is 72 on the Shore D scale. Flexural strength is 15,500 lb/in^2; compressive strength, 16,000 lb/in^2. The material has a volume resistivity of 10^{14} Ω-cm at 25 C and a dielectric strength of 480 V/mil.

CIRCLE NO. 524

Digital thermometer trades range for cost

Channel Electronics (Sussex) Ltd., P.O. Box 58, Seaford, Sussex BN25 3JB, England. Seaford (0323) 894961. Telex: 877825

A portable digital thermometer, Model D700, measures temperatures up to 700 C—but costs only £105. The price includes a carrying case and hand-held thermocouple probe. Temperature resolution is 0.1 C up to 200 C and 1 C up to 700 C. Other features include automatic cold-junction compensation, long battery life and a surface/immersion feature which ensures maximum accuracy for various applications. The instrument can be supplied with rechargeable cells. A wide range of interchangeable thermocouple probes is also available.

CIRCLE NO. 525

Only TEAC makes both on-site and in-lab cassette data recording equipment.

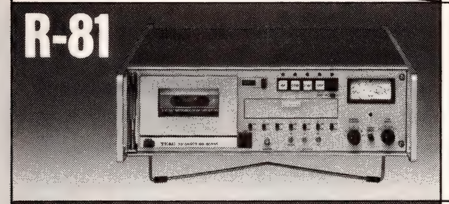
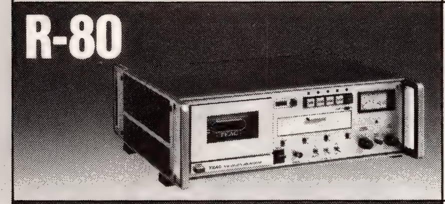
Have you been going to one manufacturer for your portable data recorders, and to another for recorders for your lab? TEAC makes things easier for you by offering a complete line of data acquisition equipment including both portable and lab models. Complete compatibility allows you to collect data in the field with a convenient portable recorder and bring it back to the lab for analysis on a full-feature lab recorder.

Of all our models, you'll find that our cassette-format recorders are the most convenient. The R-60, R-61 and R-61D portable cassette data recorders have proven extremely popular because of their ruggedness, stability of operation and light weight. They can record four channels of data in a choice of DR or FM format.

Back in the lab, the R-80 and R-81 provide big-recorder performance and features without using up a big amount of space or budget. Both can be mounted in standard E.I.A rack panels if desired.

These five cassette data recorders are part of a complete line of data acquisition equipment. Only TEAC can handle *all* your data acquisition needs.

Feature Comparison Chart

Model / Feature	Channels	Record System*	Tape Speed	Freq. Response	Power	Weight
R-81 	7	FM (DR: option)	4 speeds (7½, 3¾, 1⅞, 15/16ips)	FM: DC — 5k Hz at 7½ips	DC Car Battery (AC with AD-80)	12kg approx.
R-80 	4	FM (DR: option)	4 speeds (7½, 3¾, 1⅞, 15/16ips)	FM: DC — 5k Hz at 7½ips	DC Car Battery (AC with AD-80)	12kg approx.
R-61	4	Ch-1: FM/DR Ch-2: FM/DR Ch-3: FM Ch-4: FM	1 speed (1⅞ips)	DR: 50 — 8k Hz FM: DC — 625 Hz	DC Car Battery with CL-61 (AC with PA-2)	4.7kg approx.
R-61D	4	Ch-1: DR/FM Ch-2: DR/FM Ch-3: DR Ch-4: DR	1 speed (1⅞ips)	DR: 50 — 8k Hz FM: DC — 625 Hz	DC Car Battery with CL-61 (AC with PA-2)	4.7kg approx.
R-60	4	FM	1 speed (1⅞ips)	FM: DC — 625 Hz	AC	6.5kg approx.

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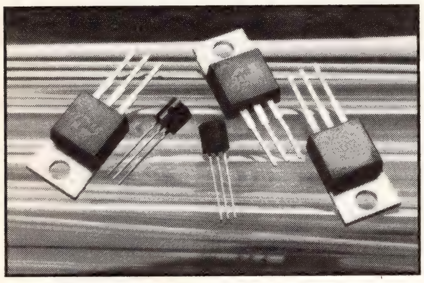
CIRCLE NUMBER 187

International New Products

Voltage-regulator ICs have built-in protection



Micro Electronics Ltd., York House, Empire Way, Wembley, Middlesex, England. (01) 903-2721. Telex: 934263.

The ML78 series of voltage-regulator ICs features internal current-limiting, thermal shutdown and safe-area compensation for built-in protection. Three versions are available: Type ML78M05 is a 5-V device in a T0-220 package, the ML78M12 has 12-V output and a T0-220 package, while the ML78L05A is a 5-V device in a T0-92 package. The three-terminal regulators require no external components or adjustment to maintain the output voltage to within ± 5%. Other features include low output impedance, low quiescent current and low noise. The T0-92 device has a maximum output current of 100 mA, while the T0-220 devices deliver up to 500 mA.

CIRCLE NO. 526

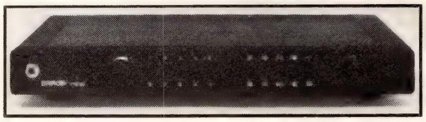
Low-noise transistors fit hybrid designs

N.V. Philips Gloeilampenfabrieken, Elcoma Div., P.O. Box 523, 5600 AM Eindhoven, The Netherlands. Telex: 51573

Several new low-noise transistors come in SOT-23 packages, which allow them to be used conveniently and reliably in hybrid circuits. All the new transistor types have noise figures of less than 4 dB at 1 kHz over a 200-MHz bandwidth. The BCF29 and BCF30 are pnp types with gains of 120 to 260 and 215 to 500, respectively. Types BCF32 and BCF33 (npn) have gains of 200 to 450 and 420 to 800, respectively. These four devices all have ratings of 20 V (V_{CEO}) and 100 mA (I_C). Higher-voltage types BCF70 (pnp) and BCF81 (npn) are rated at a V_{CEO} of 45 V and an I_C of 100 mA. Their respective gains are 215 to 500 and 420 to 800. All gains are measured at $I_C = 2$ mA. The transistors avoid intermetallic effects because they contain no aluminum.

CIRCLE NO. 527

Professional decoder unit monitors teletext signals



BARCO Electronic N.V., Noordiaan 5, 8720 Kuurne, Belgium. (56) 35.14.11. Telex: 85305.

Designed as a high quality teletext monitoring unit, the TTD 33 can be used as a separate teletext decoder in combination with any receiver-monitor. It delivers demodulated off-air video signals for on-site teletext

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CIRCLE NUMBER 188

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reception. All controls are located on the front panel. Buttons allow pretiming of data capture, selection of pages, stopping of rotating pages, double-height characters, selection of a TV program display while waiting for teletext information, superimposition of teletext information on a running TV program and adjustment of parameters such as color saturation and contrast. A LED indicates presence of a teletext signal. An option allows remote control via a cable. When combined with a BARCO CM-33 monitor and an AVD-33 demodulator, the TTD 33 can be used as a teletext field station for CATV network trouble-shooting. It is also valuable in development labs for domestic TV receivers.

CIRCLE NO. 528

Miniature thermal fuses come in 2-A version

Spirig Industries, CH 8640 Rapperswil, P.O. Box 160, Switzerland. (055) 274403. Telex: 75400.

Spirig has augmented its range of miniature thermal cut-off fuses to include a 2-A version. Other fuses in the range are rated at 3, 5 and 10 A. The new fuse provides permanent interruption of a 2-A current from a 240-V ac supply. All devices in the series can be ordered with cut-off temperatures from 80 C to 180 C in several steps. The 2-A version has dimensions of 10 × 2 mm diameter. It can be mounted as a resistor or any other axial-lead component.

CIRCLE NO. 529

Low-cost LED indicators have brass housings

Field Tech Ltd., London (Heathrow) Airport, Hounslow, Middlesex TW6 3AF, England. (01) 759-2811. Telex: 23734.

The BD range of low-cost light-emitting diodes features chrome-plated brass housings. Available in three colors, the 3-mm LEDs come in both shrouded and unshrouded head styles. In quantities of 500 or more, red and green LEDs cost only 39 p each, while yellow LEDs cost 45 p each. Other LED types are available at prices from 5 p for a basic 5-mm GAP type.

CIRCLE NO. 530

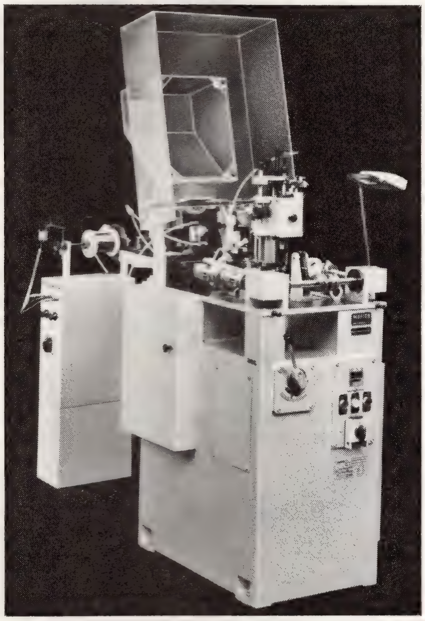
30-W switcher supply features opto-isolation

Farnell Instruments Ltd., Sandbeck Way, Wetherby, Yorkshire LS22 4DH, England. (0937)63541.

The newest addition to the G range of switched-mode power supplies is a 30-W unit. With dimensions of 145 × 88 × 33 mm, the new supply comes in four different VA combinations at 6, 12, 15 and 24 V. Units in the G series have a typical efficiency of 70% and tolerate wide variations of input voltage—from 176 to 264 V ac, or 92 to 132 V ac. Opto-isolated circuitry allows insulation tests of 5.8 kV dc from input to output. The supplies comply with conducted interference requirements of VDE 0875 curve N, CISPR curve N and BS800.

CIRCLE NO. 531

Machines wind coreless coils with stripped ends

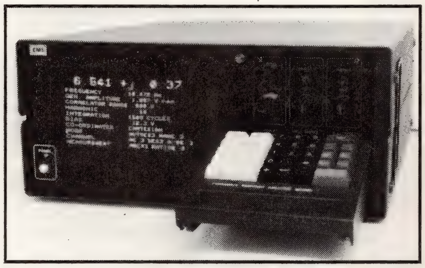


Wafios Maschinenfabrik, Silberburgstrasse 5, D-7410 Reutlingen, Federal Republic of Germany. (07121) 1461. Telex: 0729666.

Two coil-winding machines, FTU-0/97 and FTU-1/97, speed the production of single and double coreless coils. The machines are modified versions of units designed to wind coil springs. The new machines, however, not only wind coils, but also strip insulation from the ends. Thus, the finished coils are ready to be soldered into a circuit. The stripping feature works equally well with lacquered and thermoplastic-coated wire. If required, a dust-extraction unit can be fitted to the machines. Wire diameters from 0.2 to 2 mm can be handled. The maximum inside diameter for the coils is 15 mm. Outputs of up to 50 coils/min are possible.

CIRCLE NO. 532

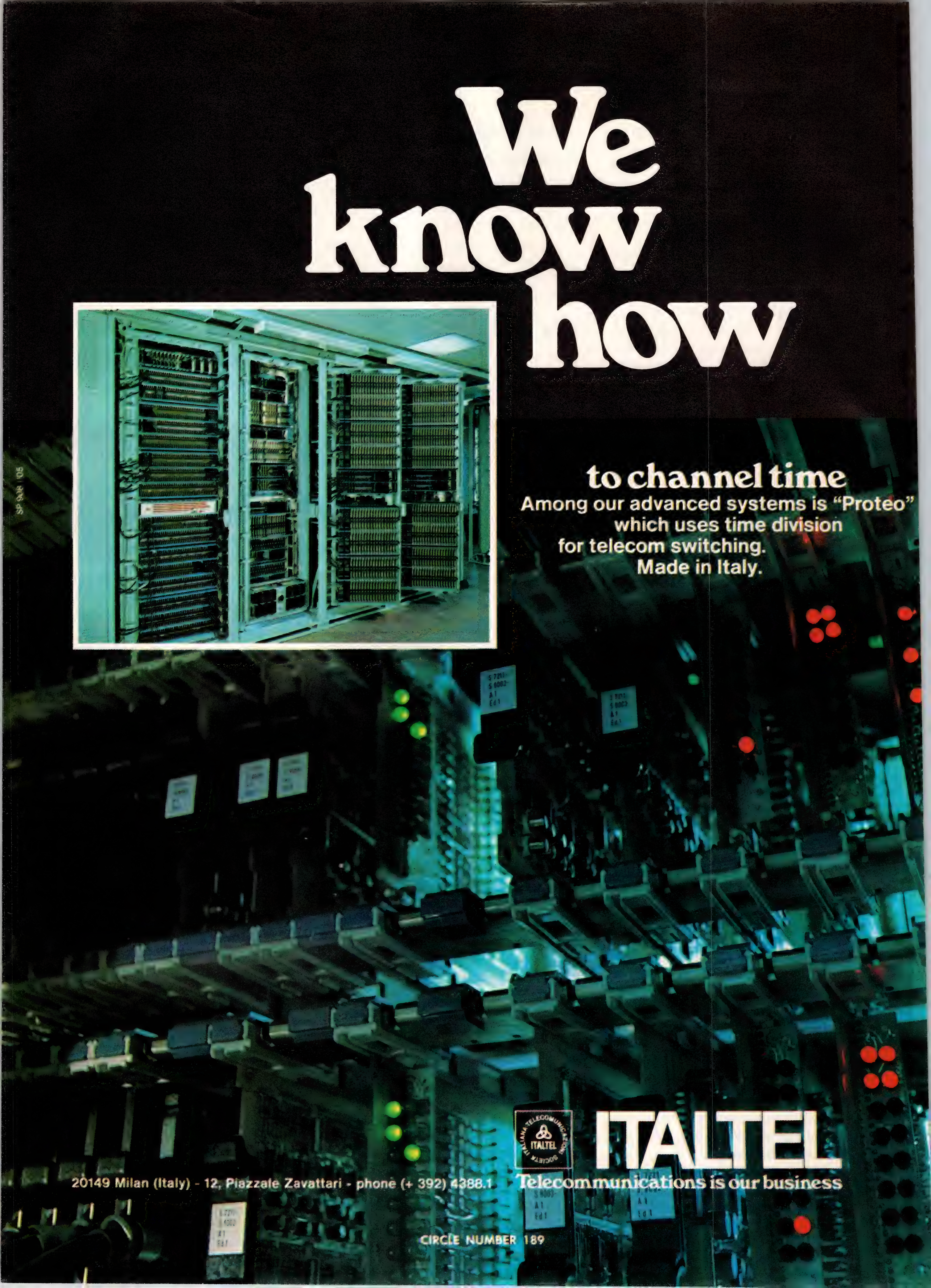
Analyzer checks dynamic system response



SE Labs (EMI) Ltd., Spur Road, Feltham, Middlesex TW14 OTD, England. (01) 890-1477.

A frequency response analyzer, type SE 2450, lends itself to the development, test and maintenance of virtually any dynamic control system or other electronic system concerned with gain and phase characteristics. The instrument can be operated manually via its pullout keyboard, or automatically by standard test routines which can be programmed into the analyzer. The SE 2450 represents an important advance in complex system measurements because it combines a range of capabilities in a single portable instrument. The instrument generates signals over a wide band of frequencies and measures gain and phase simultaneously at two separate points in a system. Two independent microprocessor-controlled correlators derive system operating parameters. Test and other data can be automatically displayed on a built-in video display unit or delivered electrically in a computer-compatible format. The SE 2450 is fully compatible with modern automatic test systems and instruments. An optional IEEE-488 bus interface allows users to link the analyzer's output to graphic plotters, hard-copy printers, computer storage devices or any bus-compatible peripheral.

CIRCLE NO. 533



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CIRCLE NUMBER 189

SP 908 / 05

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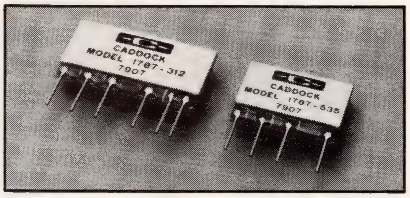


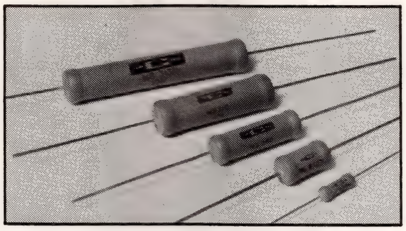
Caddock's Type 1787 Current Shunt Resistor Networks.

Absolute resistance tolerances of 0.25%, 0.1%, 0.05% and 0.02% make these 2-, 3- and 4-decade current shunt resistor networks the ideal replacement for expensive, bulky discrete resistors.

16 standard models are now available. The basic network design provides a series total resistance of 1000Ω, 100Ω, 10Ω and 1Ω. Other standard models provide commonly used variations of this basic design.

For Type 1787 data, circle Number **20**.

Non-inductive precision resistors for power switching circuits.



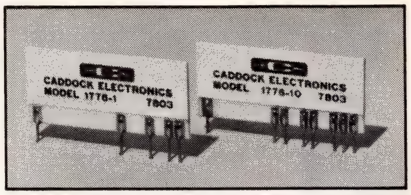
Caddock's Type MS Power Film Resistors.

Caddock's patented Non-Inductive Design in power ratings from 2 watts to 15 watts assures minimum voltage transients in all types of power switching circuits.

High stability Micronox® resistance films operate to +275°C and years-long load-life tests demonstrate extended-life stability better than 0.05% per 1000 hours.

For Type MS data, circle Number **21**.

Off-the-shelf precision decade voltage dividers.


CADDOCK ELECTRONICS MODEL 1776-1 7803
CADDOCK ELECTRONICS MODEL 1776-10 7803

Caddock's Type 1776 Precision Decade Resistor Voltage Dividers.

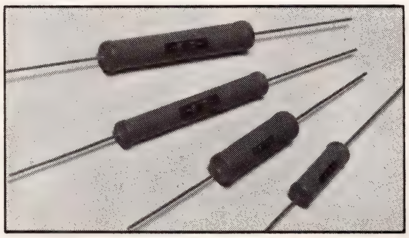
When used as a 10 Megohm input voltage divider, the Type 1776 family can provide high accuracy voltage division in ratios of 10:1, 100:1 and 10,000:1.

Type 1776 Precision Decade Resistor Voltage Dividers are now available in 25 standard models with ratio TCs from 50 ppm/°C to 5 ppm/°C. Caddock's laser production techniques keep OEM quantity prices low, too.

For Type 1776 data, circle Number **22**.

CADDOCK Resistor Technology solving problems across the board!

High stability resistors for very-high voltage control and measurement circuits.



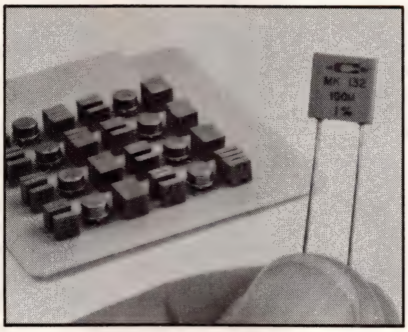
Caddock's Type MG High Voltage Resistors.

High voltage probes and control circuits make wide use of Type MG resistors for precision high voltage regulation and high voltage measurements.

Long-term stability — plus proven reliability — have also made these precision resistors first choice in communications satellite voltage control circuits.

For Type MG data, circle Number **23**.

100 Megohms in a miniature package.



Caddock's Type MK Precision Film Resistors.

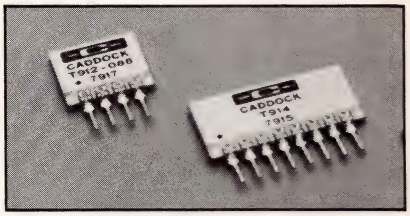
Precision values to 100 Megohms in a miniature CK 06 case make the Type MK ideal for low current designs.

These non-inductive resistors find wide application in high-impedance analog circuitry.

For Type MK data, circle Number **24**.

NEW

Resistor pairs and quads with very low ratio TC.



Caddock's Type T912 and T914 Precision Resistor Networks.

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For Type T912 and T914 data, circle Number **25**.

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ECC: Fiber optics, tantalum caps and plastic resistors share spotlight

Advances in fiber-optic components and multiprocess IC fabrication, the search for a stable resistor system that conserves gold and precious-metal powders, and the need for standardizing the packaging format for VLSI circuits provide the spurs leading to several dramatic developments to be heralded at this year's Electronic Components Conference:

- Fiber-optic components, including gallium-aluminum-arsenide (GaAlAs) lasers, will provide exceptionally high data rates (up to 500 Mbits/s), thanks to GaAs MESFET driver amplifiers, and exceptionally long life (up to 40 years), thanks to hermetic sealing. New PIN-FET receivers will operate in the second window (1.1 to 1.6-μm wavelength), handling 140-Mbit/s data rates with less than a 10^{-9} bit error rate.
- Thin-film capacitors will show improved precision at high frequencies. Despite their increasing cost, tantalum and tantalum nitrides remain the best candidates for deposition on silicon and other smooth-surfaced substrates for compatibility with ECL and other fast-logic processes. Discrete components using tantalum, in fact, will boast internal protection fuses, as well as high capacitance in smaller packages.
- Thick-film resistors will sport nonnoble metal designs: Molybdenum boride and titanium boride have proved to be well-suited to air-fired copper interconnections, though the resistors' ultimate performance—resistance value, TCR and noise—will hinge on the selection of glass frit and other film-to-substrate binding materials. Plastic-based polymeric resistors, in fact, are being examined as a low-cost alternative to conventional thick films, though their performance will depend on the binders selected as well as the substrate materials.

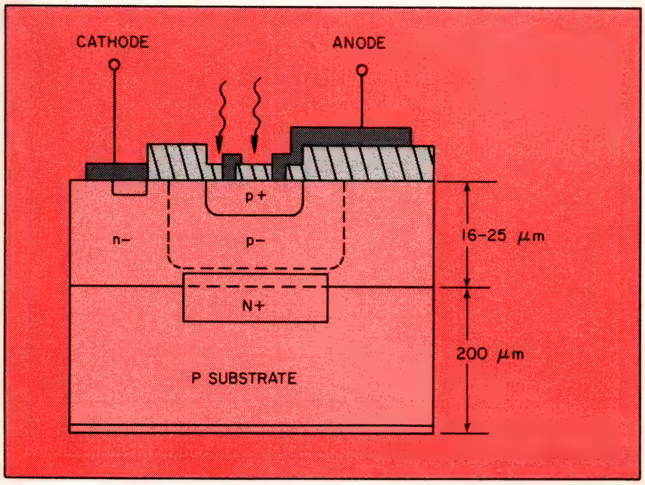
Fiber-optic spotlight

For the first time, fiber-optic components will claim a healthy share of ECC attention. One good reason is a PIN-FET hybrid fiber-optic receiver intended for long-range transmission in the 1.1 to 1.6-μm-wavelength region. It provides better performance than the germanium avalanche photodiodes (APD) currently being investigated.

Stephan Ohr
Components Editor

According to R.C. Hooper, D.R. Smith and B.R. White of Great Britain's Post Office Research Center (Ipswich, Suffolk), this receiver improves on germanium, GaInAs, and GaInAsP APD receivers, which suffer from limited sensitivity due to high bulk current leakage and avalanche shot noise. The PIN-FET receiver has a −44.2-dBm sensitivity, and can register digital signals up to 140 Mbit/s with less than a 10^{-9} bit error rate. A GaInAs/GaAs p-i-n photodiode, coupled with a 0.7 × 300-μm-gate GaAs MESFET preamplifier (Plessey GAT5), is employed by the receiver. The gate-source capacitance for the preamp is 0.23 pF, and gate leakage is less than 10 nA. In addition, the p-i-n photodiode requires a 20-V bias, but has a capacitance less than 0.1 pF and a dark current less than 20 nA.

Another significant fiber-optic development is a fast-responding, low-voltage p-i-n photodetector from the Spectronics Division of Honeywell (Richardson, TX). Though capable of low-cost manufacturing, the detector device provides high reliability with hermetic sealing and easy coupling with a wide variety of optical fibers. Incorporating Spectronics' "sweet spot" technology, the photodetector has a responsivity better than 0.34 μA/μW at 820 nm, a response time (10 to 90%) less than 3 ns, and a depletion voltage less than 5 V. Dark current for the device is

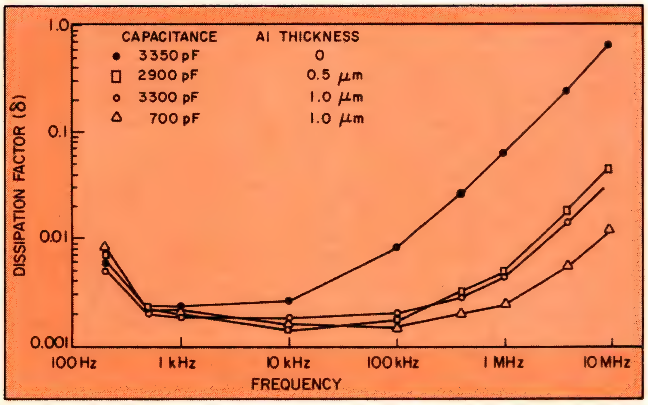


This fast-responding, low-voltage p-i-n photodetector employs a p^- active junction inside an n^- epitaxial layer. The top of Spectronics' chip is 800 μm square, with a photosensitive area 265 μm in diameter.

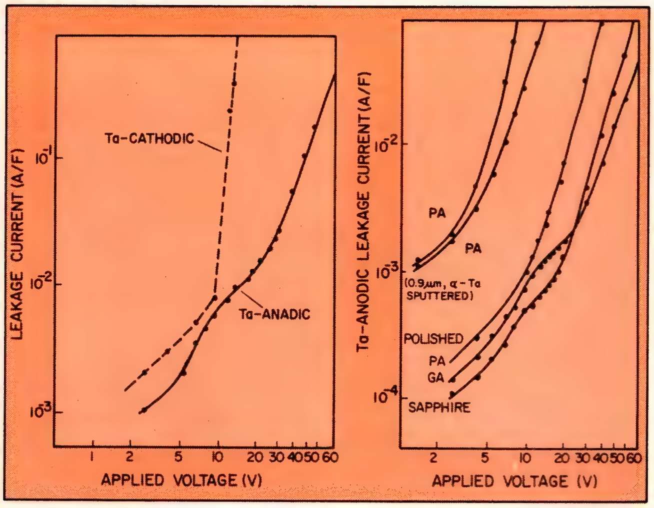
less than 1 nA, with 10 pA typical.

As reported by Bobby Hawkins and R. Stephen Speer, optical-fiber coupling of many devices can be made more efficient by varying the depletion-layer widths of silicon p-i-n photodiodes. A large chip area will promote good optical transmissions into a variety of optical-fiber types and widths, but will also consume more power, calling for depletion voltages on the order of 15 to 100 V. Wide depletion areas, moreover, will provide good responsivity but will slow down the response time. Narrow depletion widths, on the other hand, will encourage fast response time, but will lower the responsivity.

Spectronics' solution is to map out a depletion width on an epitaxial structure—that is, make it narrow but deep. A p− boron diffusion forms the active junction inside an n− epitaxial layer. The top is the 800-μm square. The active junction area is 165 μm, with an unobscured active area of 100-μm diameter inside an annular metal anode. The total photosensitive area has a diameter of 265 μm.



Tantalum thin-film capacitors provide lower dissipation factors at high frequencies with an aluminum underlay, according to findings released by Bell Laboratories.



The leakage current of tantalum thin-film capacitors is much lower on smooth-surfaced substrates such as sapphire, glazed alumina and polished polycrystalline alumina than on thick-grained substrates. According to research conducted at Fujitsu, an additional layer of tantalum nitride slightly reduces the current leakage of unpolished polycrystalline alumina (left).

A high-index glass bead (n = 1.9), mounted to the detector's surface with RTV silicone rubber, effectively focuses the light output from 50 to 200-μm-core diameter fibers (NA from 0.25 to 0.50) into the detector. When mounted in a BeO substrate, inside a TO-46 can, the p-i-n detector provides a uniform response area, or "sweet spot," which is 300 μm in diameter.

The same technology, in fact, is harnessed to a Spectronics planar double-heterostructure GaAlAs LED, also described by Hawkins and Speer. A high-efficiency double heterostructure consisting of n− GaAs and n− GaAlAs layers on a p− substrate, with a high-index glass bead sitting on the etched window of the chip, is employed by the LED to provide a measured 275 to 350 μW into a 100-μm fiber core. Typical voltage drop is 1.6 V and drive current is 100 mA. The response time (rise time) is typically 12 ns, with maximum power output in the vicinity of 820 nm.

GaAlAs LEDs aside, GaAlAs lasers are the subject of two discussions. K.H. Cameron, M.R. Matthews, K.R. Preston and D.W. Smith of the British Post Office Research Center will describe the packaging and construction of a hybrid laser transmitter that sports fast rise and fall times on the order of 500 ps and modulation capability in excess of 500 Mbit/s. William H. Dufft of Bell Telephone Laboratories (Reading, PA) will present a long-life double-heterojunction laser that emits light in a 7 × 40° elliptical pattern from a 0.12-μm-long p-active area sandwiched between p− and n− GaAlAs layers.

An ECL-compatible GaAs MESFET amplifier drives the British Post Office laser with a 75-mA drive current from a ±5 V supply. The stripe laser is capable of launching 38 to 50% of the power into a 125-μm-OD fiber having a 62-μm-core diameter (NA = 0.2) with the aid of a microlens. Total power consumption is approximately 600 mW.

The Bell Labs laser has stripe-geometry and heterojunction layers that enable it to operate at much lower current densities than can be achieved with homojunction structures. It can deliver more than 3.6 mW into a 50-μm fiber core having a cladding diameter of 125 μm and an NA of 0.23.

Moreover, the GaAlAs laser is projected to have a lifetime of 40 years while operating at room temperature. The reasons? Hermetic packaging and environmental testing.

Thin film capacitors—still tantalum

Despite the spiraling cost of tantalum, there seems to be no decrease in interest in high-precision tantalum capacitors.

Up to now, thin-film Ta capacitors for high-precision applications have been limited to frequencies below 10 kHz because of the resistance of the Ta anode, which tends to increase the dissipation factor at

Characteristics of polymer resistors on various substrates (measured resistance and TCRs from +25 to +125 C)

		Substrates											
		Paper		Paper		Mylar		Alumina		Phenol	Epoxy glass	Polyimide	Enameled Aluminum
Terminations		4929		4049		4049		6838		6838	6838	6838	6838
Product number	Nominal value (Ω/□)	R	TCR	R	TCR	R	TCR	R	TCR	R	R	R	R
4215	50	23	-500	23	-700	40	+332	62	+600	30	44	54	62
4222	200	61	-860	66	-920	114	+173	188	+420	105	158	192	163
4232	2 k	1.6 k	-1350	1.6 k	-820	1.9 k	+104	3.0 k	+180	2.3 k	26 k	2.9 k	2.2 k
4242	20 k	20 k	-1040	21 k	-820	25 k	+380	45 k	+450	17.9 k	23 k	11.9 k	31.6 k

Note: All silver conductors cured 1 h at 120 C.
Resistor size 5 mm × 2.5 mm (wide).

All resistors cured 6 h at 120 C.

Performance of conductor compositions on Mylar membrane switches

Comp.	Ag content	Binder system	Typical resis. (mΩ/□)	Dried thickness (μ)	Resis. 25-μ film (mΩ/□)	Adhes.	Solvent	Vapor press. solvent (25 C-mm)	Vapor press. solvent (95 C-mm)
4049	60	Polyester	50	20	40	Excellent	Benzyl alcohol	0.09	8.7
4226	35	Polyester	800	30	900	Good	Benzyl alcohol	0.09	8.7
4198	70	Polyvinyl	30	25	30	Good	BCA	0.35	20
4081	41	Acrylic	300	30	400	Fair	BCA	0.35	20
4929	70	Acrylic	10	40	15	Fair	BCA	0.35	20

BCA = butyl "cellosolve" acetate

high frequencies. However, according to L. G. Feinstein and R. G. Pagon of Bell Labs in Allentown, PA, depositing the Ta on top of an aluminum film reduces the series resistance of the capacitor as well as the dissipation factor. In this way, the capacitor's frequency range is extended to 1 MHz.

The process involves depositing 0.25 to 1.0 μm of Al by evaporation (or magnetically enhanced sputtering) on a glazed alumina substrate. Nitrogen-doped Ta is deposited over the Al layer by magnetically enhanced sputtering or dc processes. The capacitors are patterned and anodized for 190 V.

Comparing performance factors such as capacitance change, temperature coefficient of capacitance (TCC), dissipation factors, and leakage currents with those of Ta thin-film capacitors not having the aluminum undercoat reveals some interesting results. Without the Al underlay, a 3300-pF capacitor has a typical dissipation factor of 0.07. In contrast, from 1 to 100 kHz, the dissipation factor (tan δ) is less than 0.002 for 700 and 3300-pF capacitors having the Al underlay. And at 1 MHz, the dissipation factor is 0.0026 for the 700-pF capacitor and 0.005 for the 3300-pF capacitor.

The Al undercoat, it should be noted, apparently does not affect the capacitance value, the leakage current or the TCC. However, the leakage current of tantalum thin-film capacitors does appear to be influenced by granular structure of the substrate on which it is deposited. That's the conclusion of Masataka Koyama, Minoru Terashima and Masateshi Fujimeri of Fujitsu (Kawasaki, Japan). They also conclude that alpha-tantalum films magnetically sputtered on the surface of glazed alumina, polycrystalline alumina, polished polycrystalline alumina, sodium glass, Pyrex glass, quartz and sapphire substrates show somewhat lower capacitance and significantly higher leakage currents on polycrystalline alumina than on the smoother, glassy substrates. On polycrystalline alumina, the capacitance density proves to be 5 to 10% less than on the surface of glassy substrates. And current leakage at 50 V tends to increase dramatically after one minute.

The Fujitsu group believes that alpha-tantalum forms differing structures on polycrystalline alumina and on smoother substrates. The structure, in fact, can be altered by building it over a layer of highly nitrogen doped tantalum nitride, and increasing the thickness of the alpha-tantalum film from 5000 to 9000 Å. Consequently, the current leakage of the resulting capacitor comes much closer to performance on amorphous substrates.

Meanwhile, M. H. Rottersman, R. C. Petetti, A. R. Adolt, and M. J. Bill from Bell Labs in Allentown report that while the impact of reducing the anodization voltage from 190 to 70 V may be small on dissipation factor, TCC and dc leakage current, the effect of nitrogen concentration on alpha-tantalum films is very significant. Increased nitrogen concentration, for example, tends to lower the capacitance value by approximately 7%. The impact of nitrogen concentration on TCC (120 to 170 ppm/°C) and dissipation factor (less than 0.0020), however, is typically less severe.

Other tantalum-capacitor developments include a solid-tantalum capacitor with an internal fuse from Union Carbide (Greenville, SC) and a new solid-tantalum device from Sprague (North Adams, MA).

The nongold rush

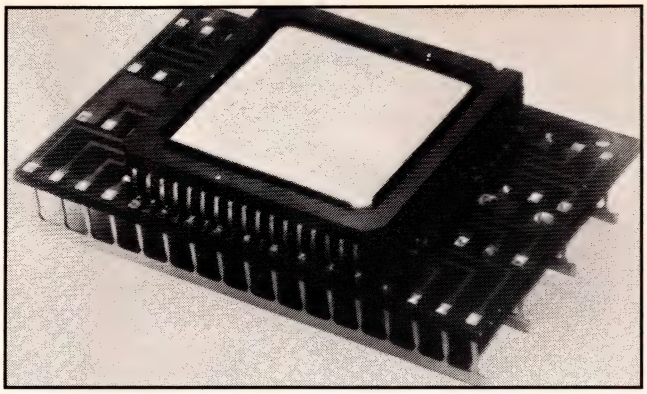
Over in thick-film resistors, the skyrocketing cost of gold and other precious metal is intensifying the search for nonprecious-metal substitutes in resistors, capacitors and interconnections.

The quest has produced results at the National Cheng-Kung University in the Republic of China (Taiman, Taiwan). A group there has recently discovered that a composition of glass frit and other thick-film binders affects the performance of a nonnoble metal resistor as much as metal powder. As reported by Tien-Shou Wu, Toyotaro Shiramatsu, Wen-Chyuan Sheu and Be-Wei Chen, an air-fired copper conductor system, while providing good interconnection results, is not compatible with resistor systems based on noble-metal oxides such as ruthenium oxide or palladium oxide.

Experiments at Cheng-Kung University reveal that only resistor compositions with molybdenum boride (MoB_2) or titanium boride (TiB_2) prove to be compatible with air-fired interconnections, though resistor characteristics tend to vary widely with the composition of the glass binding materials. With such materials occupying 30% of the weight of the thick-film material, a glass composition of lead-borosilicate, modified with Bi_2O_3, for example, would provide totally different sheet resistivities for the molybdenum and titanium powders. This glass composition produces a sheet resistivity of 120 Ω per square for the MoB_2 resistor, and 800 Ω/sq for the TiB_2 resistor.

Paradoxically, glass-binder compositions yielding the highest sheet resistivity also provide the weakest temperature coefficients. In MoB_2, for example, lead borosilicate (70 PbO/18 B_2O_3/12 SiO_2) produces a maximum sheet resistivity of 2760 Ω/sq, but a loose temperature coefficient of +2325 ppm/°C. An alumino-borosilicate (42 BaO/40 SiO_2/9 ZnO/6 B_2O_3/3 Al_2O_3) glass binder, in contrast, provides a sheet resistivity of only 212 Ω/sq in MOB_2,but a tight negative tempco of −7 ppm/°C. (In all experiments, resistor compositions were fired to copper interconnection lines on an alumina ceramic substrate.)

Not only will the composition of binding materials significantly influence the properties of resistors and conductors on alumina hybrid substrates, but they also will affect the properties of thick-film materials on Mylar, other polyesters and plastics. The special problems of adhering thick films to Mylar, as in the manufacture of membrane switches, will be discussed by W. T. Hicks, T. R. Allington and Van Johnson of DuPont Co.'s Electronic Materials Division (Wilmington, DE). The proliferation of low-cost hybrid-circuit substrates such as Kapton, polyimide, epoxy glass and even paper has not only intensified silver conductor research but has also sponsored the development of polymer-based resistor compositions as well.



A 68-pin multiple-in-line package (from Bell Labs) mates a JEDEC chip carrier to a DIP-configured PC board using an epoxy-glass adapter with four rows (0.300 in. apart) of 17 pins (0.100 in. apart).

Four soon-to-be-announced DuPont resistor compositions, for example, use binding material of phenolic resin.

Four basic resistance values will be provided: 50-Ω/sq nominal sheet resistivity from the 4215, 200 Ω/sq from the 4222, 2 kΩ/sq from the 4232 and 20 kΩ/sq from the 4242. As the table indicates, polymeric thick-film resistors will provide relatively consistent values on a wide variety of substrates, even though, as the DuPont researchers note, the solvent material tends to seep into the pores of different substrates—leaving dried, relatively conductive carbon particles on the surface—and lower the resistance values somewhat. The more impervious substrates like enameled aluminum, polyimide and epoxy glass provide consistently higher resistance values. ▪▪

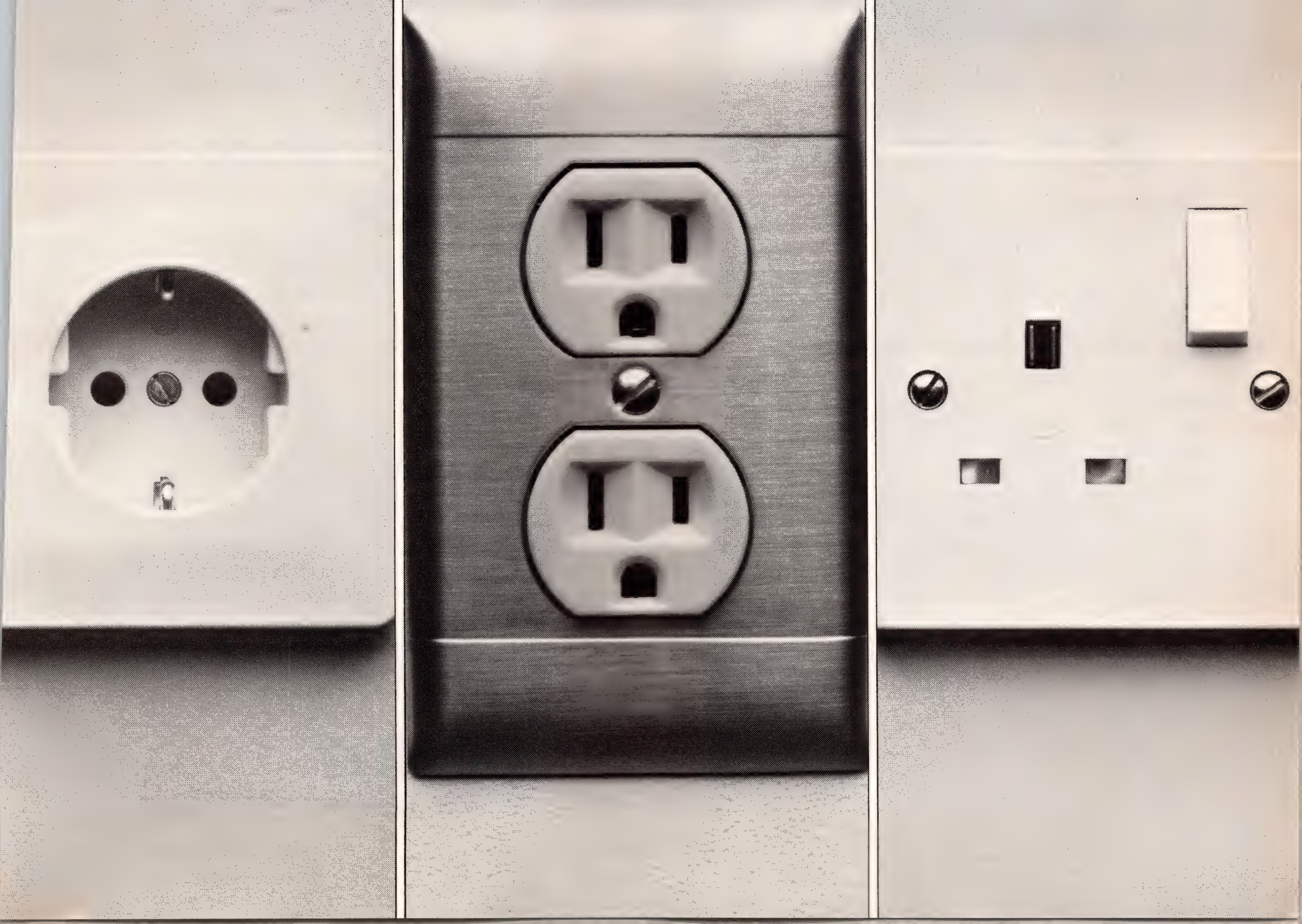
Want to go?

The 30th annual Electronic Components Conference will be held April 28 through April 30, 1980, at the Hyatt Regency Hotel in San Francisco, CA. The conference is jointly sponsored by the Electronic Industries Association and the Components, Hybrids and Manufacturing Technology Group of the IEEE. For program and registration information, contact James A. Bruorton, 1980 Electronic Components Conference, c/o Union Carbide Corp., P.O. Box 5928, Greenville, SC 29606; (803) 963-6348.

¿Puede su computadora
funcionar con esto?

Kommt ir computer
auch damit zurecht?

Can your computer
handle these?



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AC power poses lots of problems for the systems designer: brownouts, dropouts, high-voltage spikes and the day-to-day fluctuations in amplitude and frequency. International applications make things even tougher with voltage and frequency variations as well as new and different power supply standards.

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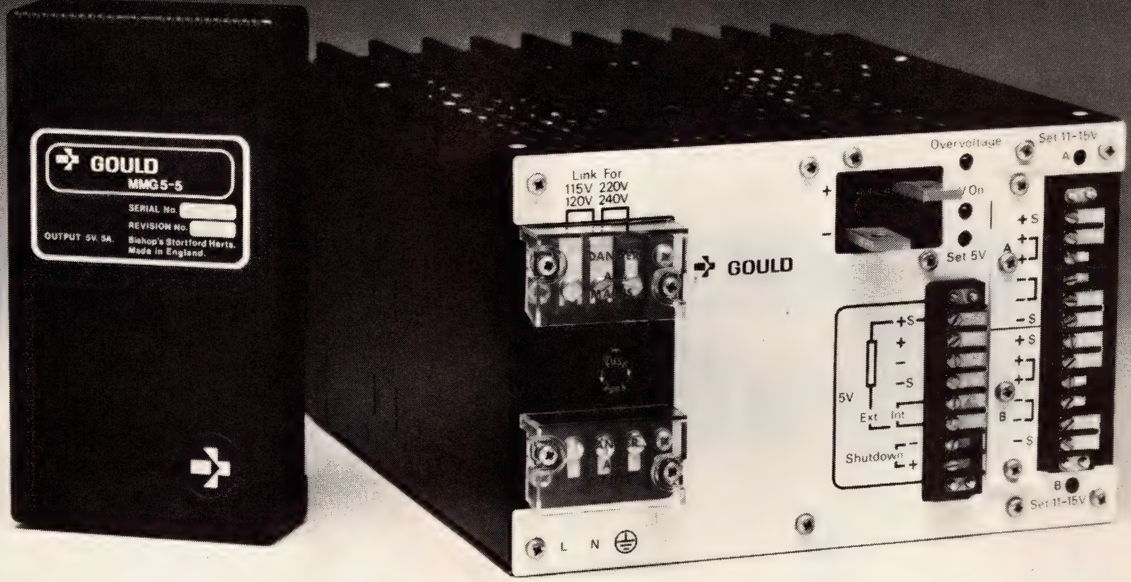

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Output Voltage	Watts MMG 25	 50	 MG 100	 150	 200	 300	 400	 500
5	X	X	X		X	X		X
12	X	X	X					X
15	X	X	X		X			X
24	X	X	X		X	X		X
5 & ± 15				X			X	

In addition to our U.S. facility, power supply manufacturing operations in England and Germany and service facilities throughout Western Europe assure complete field back-up for the MG switcher family.

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CIRCLE NUMBER 28

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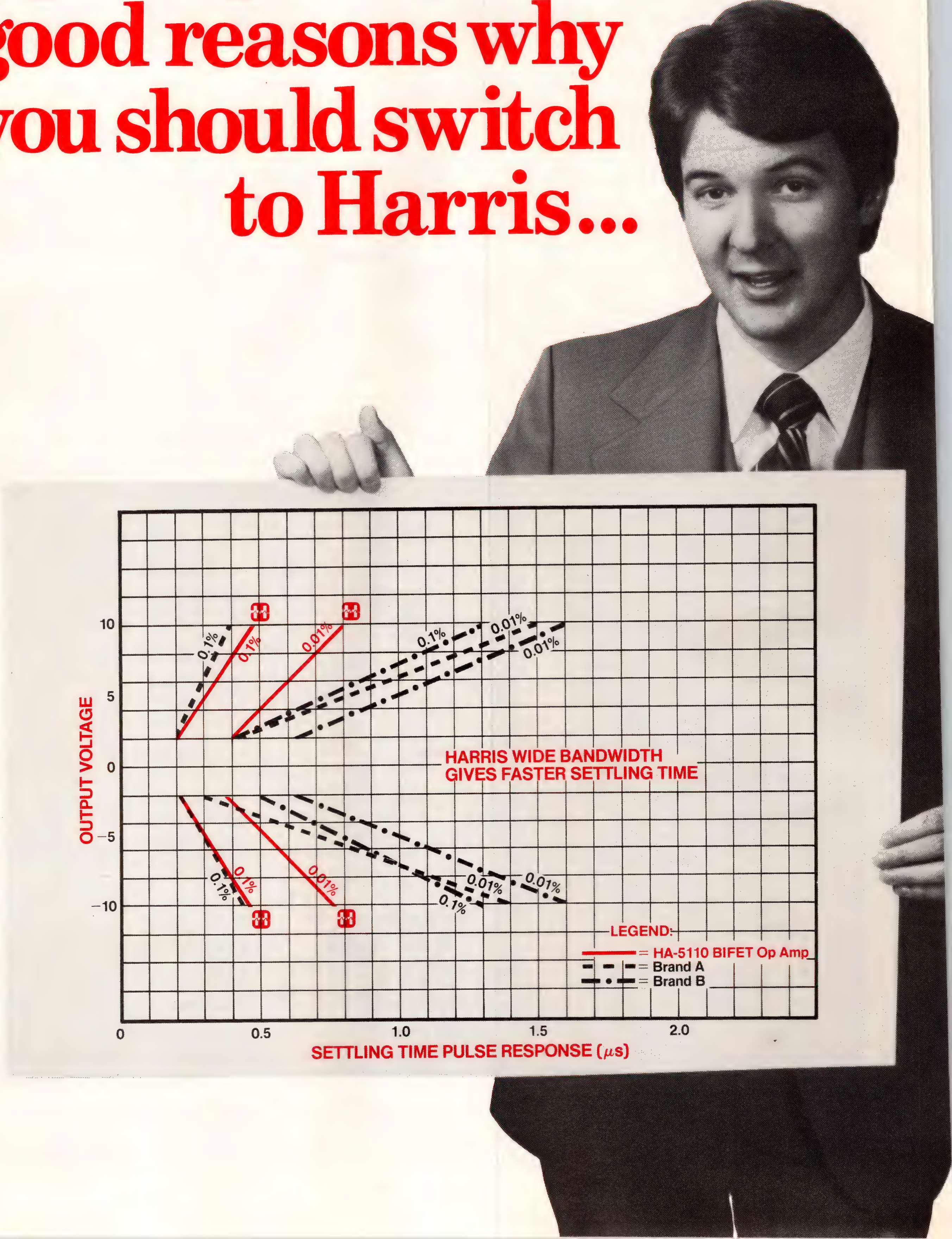
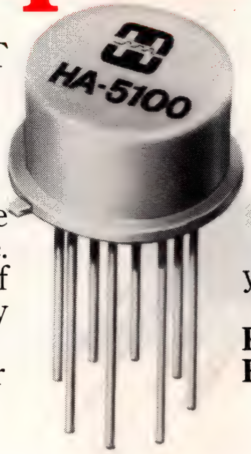
CIRCLE NUMBER 26

"If you compare BIFET Op Amps, there are three good reasons why you should switch to Harris...



1. Wider bandwidth
2. Faster settling time
3. More stable over temperature.”



New Harris HA-5100 and HA-5110 BIFET Op Amps offer unmatched dynamic performance and accuracy at costs beginning at $3.50 each (100-piece quantities)!

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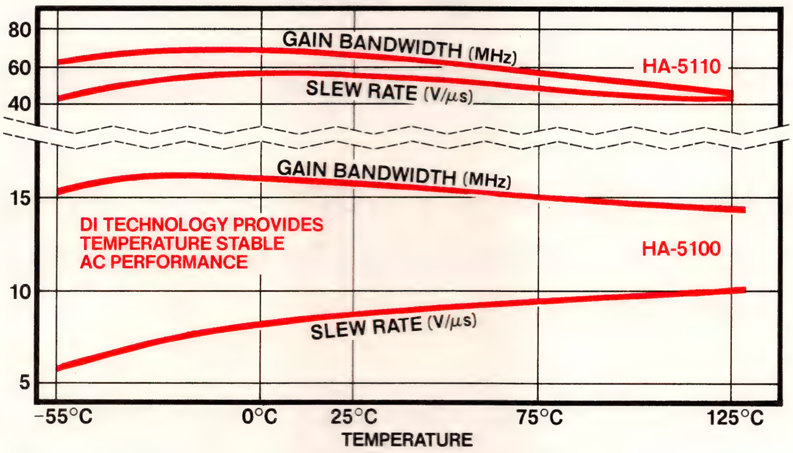
HA-5100/5110 Ac Parameters/Temperature



Harris BIFET Op Amp Performance

PARAMETERS	TEMP	UNITS	5100-2 (−55° to +125°C)	5100-5 (0° to +75°C)	5105-5 (0° to +75°C)	5110-2 (−55° to +125°C)	5110-5 (0° to +75°C)	5115-5 (0° to +75°C)
V_{OFFSET} (MAX)	+25°C	mV	1.0	1.0	1.5	1.0	1.0	1.5
I_{BIAS} (MAX)	+25°C	pA	50	50	100	50	50	100
	FULL	nA	10	10	20	10	10	20
SLEW RATE (MIN)	+25°C	V/μs	8	8	6	40	40	35
G.B.W.	+25°C	MHz	18	18	8.5	60	60	80
SETTLING TIME[1]	+25°C	μs	1.7	1.7	2.0	0.85	0.85	1.0

[1] Settling Time to 0.1%, 10 V step.

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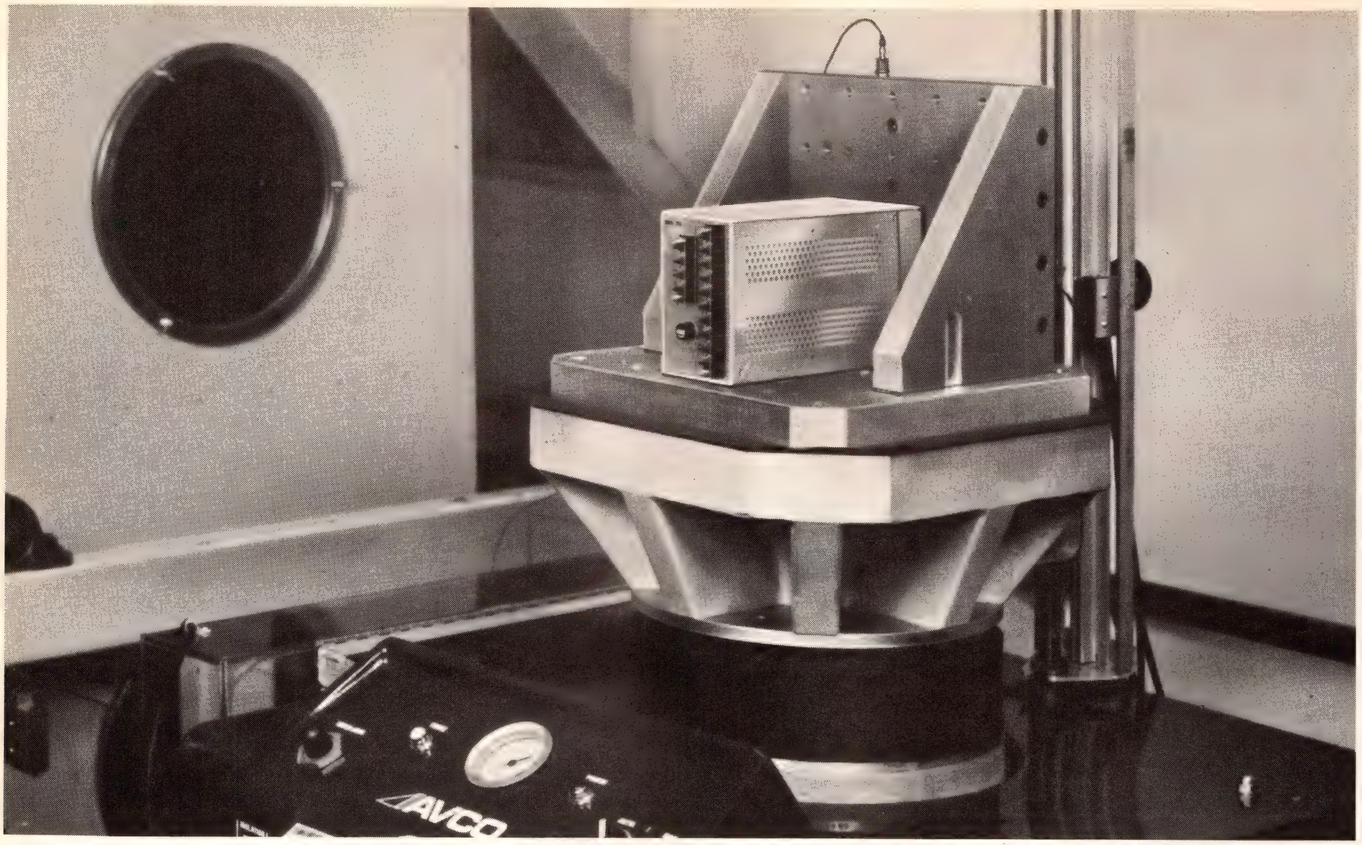
CIRCLE NUMBER 29



a 100 watt switcher is shown on the shake table

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Vibration testing:
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CIRCLE NUMBER 30

Some high-level facts

In an industry where 25 and 30% growth rates are more often the rule than the exception, it's an eye-opener that microprocessors are being tagged for growth rates exceeding 40% over the next four to five years. A recent market projection by National Semiconductor sees total worldwide microcomputer sales (including CPU, memory, and peripheral chips) rising from about \$700-million in 1979 to better than \$2-billion in 1982.

The surprising part of the National projection is the rapid growth predicted, in particular, for the high-end μP, whose applications include minicomputers, advanced instrumentation and intelligent terminals. This segment will rise in dollar value almost ten times—from about \$44-million in 1979 (about 6% of the μP market) to almost \$400-million in 1982 (about 18%). Midrange processors, on the other hand, although representing about 56% of the market in 1979, will grow strongly, yet drop in market share—down to about 43% in 1982.

National also sees a strong move toward high-level languages. In 1979, it says, only about 15% of midrange applications software was written in high-level languages; by 1982, this figure will rise to about 45%. And the impact of high-level languages is even greater at the high end—from 50% of the programs in 1979 to 80% in 1982.

The message for designers is clear: There is no letup in sight for the unremitting spread of μPs into new applications. Furthermore, with high-end applications growing particularly fast, trouble is brewing for designers who aren't fluent in such high-level languages as Pascal and Fortran.

Steve Scrupski

Stephen E. Scrupski
Senior Editor

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CIRCLE NUMBER 31

Pentagon warning system can't handle pressure, says GAO

The performance of a computer system designed to warn the President of impending worldwide crisis situations or military action against the U.S. has sparked a heated debate between Defense Department officials and the General Accounting Office (GAO).

The system, called Wimex, consists of 35 Honeywell 6000-series computers at 27 locations linked by a complex system of sensors, coding and decoding units, and terminals.

According to a GAO report, design flaws make Wimex prone to failure under pressure. The report also says the Defense Dept. has spent about $1-billion trying to make Wimex work and has requested another $140-million this year for that purpose.

Pentagon experts insist the system works as planned but conceded that there have been problems. Commander Wilbur Zanin, director of the National Military Command Center, says there have been some malfunctions in the information retrieval subsystem connected to the Wimex computers, but adds that backup retrieval methods are available when they occur.

Appeals court backs FCC ban on linear amps

The District of Columbia U.S. Appeals Court has upheld the Federal Communications Commission's 1978 rules banning the manufacture and sale of external amplifiers able to operate between 24 and 35 MHz—regardless of whether they can be used on other frequencies.

The 1978 ban is a tougher version of rules issued by the FCC in 1975 to curb the illegal use of the devices to boost the transmission power of CB radios. Under the 1975 rules, the devices could be sold only if they could be used on the four frequencies used by amateurs. The rules were tightened after manufacturers began distributing broadband amps usable for the amateur bands but designed primarily for the 27-MHz frequency assigned to CB users.

The FCC had been challenged by a group of amateur radio operators, who argued that the ban on linear amps infringes on their ability to enjoy their hobby. However, the court ruled that the FCC, with broad discretionary authority granted by Congress, has acted reasonably in issuing the rules.

Vishay vs SFERNICE resistor case calming down

Vishay Intertechnology Inc. (Malvern, PA) and the Societe Francaise de L'Electro-Resistance (SFERNICE) are settling their differences over patent claims for precision-resistor chips.

In a suit brought before the International Trade Commission, Vishay charged SFERNICE with patent infringement in December, 1978, and sought to have resistors manufactured by the French company barred from the U.S. SFERNICE filed a counter-claim, charging Vishay with using the commission to help maintain a monopoly. The French firm also sued in Federal court and in November, 1979, won an antitrust judgment against Vishay valued at $1.5-million.

However, a settlement reached by the two companies eliminates that verdict and terminates all other actions against either party in the U.S. and France. Vishay will pay SFERNICE $2-million and issue a note at 3% interest for another $985,000 to cover the court judgment and legal fees. SFERNICE will pay Vishay royalties amounting to 3% of worldwide net sales of the precision foil resistor chips covered by Vishay patents.

In light of the agreement, an ITC administrative-law judge proposes that the commission drop its involvement in the dispute. The full commission will rule on the judge's recommendation after hearing public comments, but with both parties pressing for termination, approval is likely.

Invest in space manufacturing, GAO warns U.S.

Unless law makers decide to join private business in financing research into space manufacturing, the U.S. may find itself lagging far behind when the technological and economic benefits from such projects start flowing, warns the General Accounting Office. In theory, the vacuum of space is perfect for manufacturing processes ranging from extremely pure semiconductor-crystal production to creation of metal alloys and medical products that cannot be created on earth.

According to the GAO, the U.S. should be spending two or three times the current $20-million currently allotted to the National Aeronautics and Space Administration for research into space technology. Currently, the Soviet Union, Japan and several Western European nations are investing heavily in space-manufacturing research, counting on the huge potential commercial payoff to eventually recover the costs.

Interestingly, the key to Japanese and European space-manufacturing projects is NASA's space shuttle. In 1982, it is scheduled to put Spacelab, now being built by the 11-member European Space Agency (ESA), into orbit—and along with it, 39 material-processing experiments. Japan also plans to use the space shuttle and is developing experiments in the manufacture of semiconductors and optics.

Sat-comm-frequency shortage ahead, says NASA

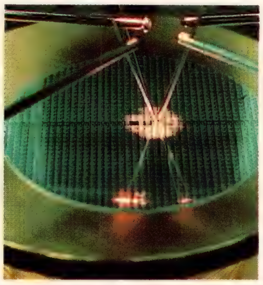
By 1990, the growing demand for satellite communications will have saturated the available spectrum space in the radio bands now used to relay voice, data and video signals around the world. And NASA, which made the prediction after conducting studies, is planning to do something about it.

Noting that 2000 orbiting transponders will be needed by the end of the century compared to today's 200, NASA reports it will start working on technology to use the Ka-band frequencies (20 to 30 GHz) in addition to the current C-band (4 to 6 GHz), and Ku-band (11 to 14 GHz). The Ka band could provide five times the spectrum space now available on Ku and C bands, NASA says, and enhance the capabilities of satellites 50 to 100 times.

The only hitch in the projected communications satellite boom is the ability of the world's space agencies to launch them all. According to NASA, some of its space-shuttle customers are worried that even over the next five to six years, their demands will exceed launch capacity.

Other findings in the NASA studies suggest that most data-services communications will travel by computer-to-computer links, nearly all of which will involve high-speed, real time transmissions.

No compromise solutions.



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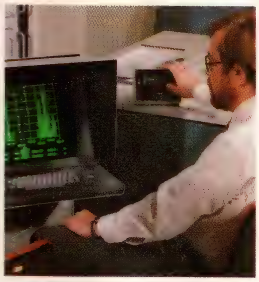

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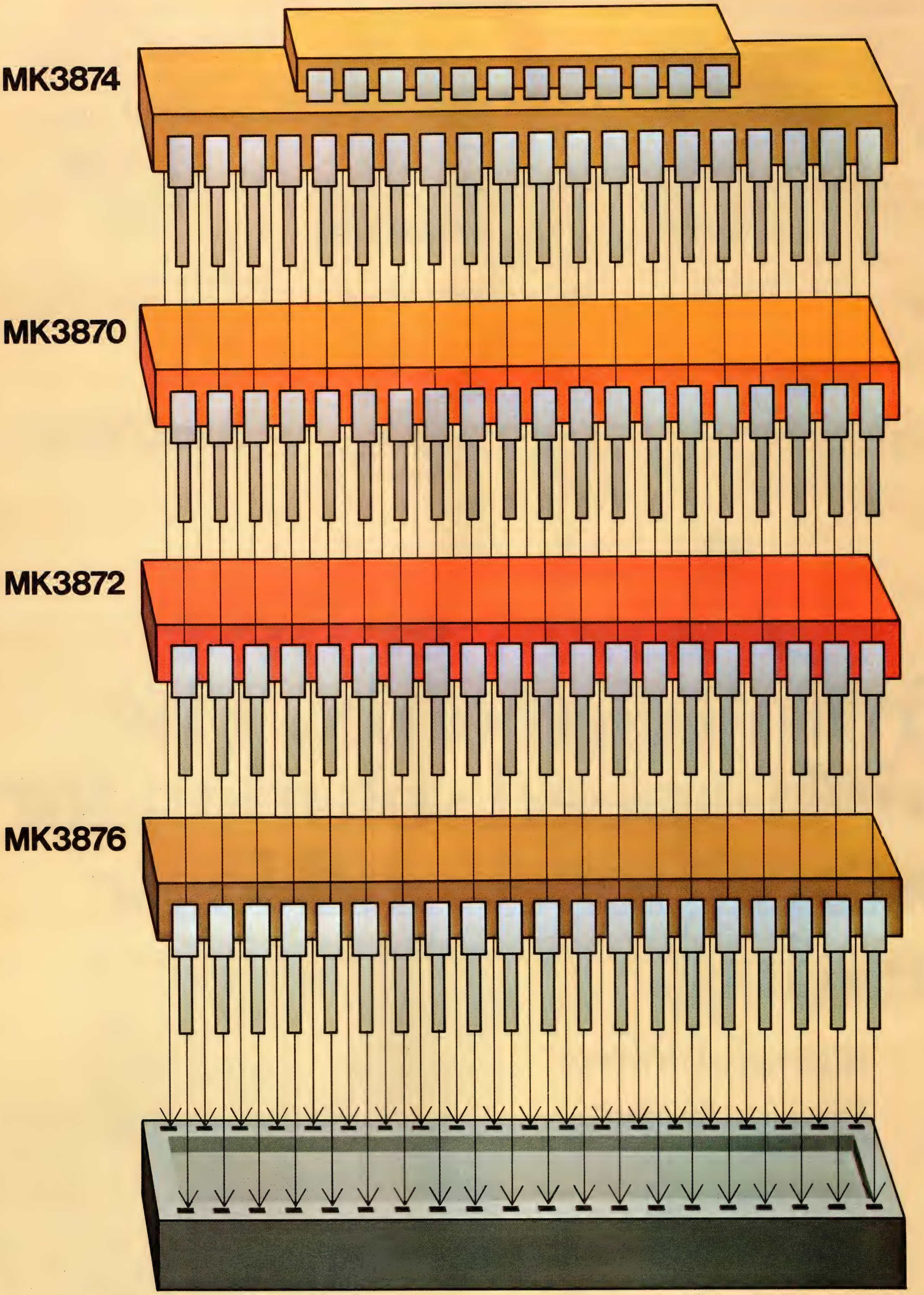
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Microcomputer Momentum.

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Let's say you start with the 2K bytes of ROM and the 64 bytes of RAM in the 3870. Need more RAM? Double it with the 3876. In the same socket. Need more ROM and RAM? Get 4032 bytes of ROM and 128 bytes of RAM with the 3872. In the same socket. Want to prototype and test your systems prior to ordering mask ROM programs? Plug in the 3874 with its piggyback EPROM and emulate all 3870 family members. In the same socket.

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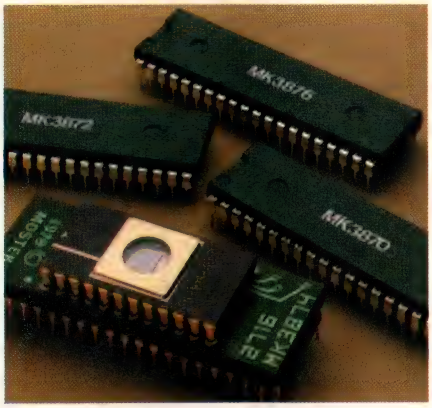

Design it in with confidence.

Mostek's 3870 is the proven 8-bit single chip microcomputer industry standard. Over a million parts have already been shipped. For hundreds of applications. From microfilm recorders and electrocardiographs, to appliances, computer peripherals, and more. Supported by multiple second-sources, the 3870 has made a whole new technology affordable for scores of cost-sensitive applications.

It's a powerful way to design.

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MK3872	4032x8	128x8	32/30*	+5V
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MK3876	2048x8	128x8	32/30*	+5V

*with standby power mode option

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CIRCLE NUMBER 39

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Career Opportunity Checklist for Engineers

	YES	?	NO
INDUSTRY GROWTH AND STABILITY			
No one wants to be "phased out," so check for security:			
Is the company part of an industry that's vital, growing, dynamic?	☐	☐	☐
Will the growth continue throughout the 1980s and beyond?	☐	☐	☐
COMPANY HISTORY AND REPUTATION			
You can tell a lot about a firm by its track record:			
Is the company recognized and respected in the industry?	☐	☐	☐
Have sales and profits increased at a steady rate?	☐	☐	☐
Is it known for its technological innovations?	☐	☐	☐
Are its employees motivated and well rewarded?	☐	☐	☐
Does the company seek technological employees on a permanent, ongoing basis?	☐	☐	☐
WORKING CONDITIONS AND ENVIRONMENT			
Look for good people, team spirit, and top-notch facilities:			
Is the atmosphere one of loyalty, pride, and achievement?	☐	☐	☐
Do employees welcome the challenge of difficult assignments?	☐	☐	☐
Are creativity and independent thinking encouraged?	☐	☐	☐
Are the company's engineering goals clear-cut and attainable?	☐	☐	☐
THE COMPANY LOCATION			
Relocation is a big professional and personal commitment.			
Is the company located in an existing or emerging electronics center?	☐	☐	☐
Are there major universities and other technological resources nearby?	☐	☐	☐
Will the company assist me in relocating?	☐	☐	☐
Can I provide my family a comfortable lifestyle in this area?	☐	☐	☐
Are there cultural and entertainment opportunities?	☐	☐	☐
Is there a variety of recreational and leisuretime activities?	☐	☐	☐
Are the climate and surroundings pleasant?	☐	☐	☐
PERSONAL AND PROFESSIONAL GROWTH			
Job satisfaction means more than just a paycheck:			
Does the company give full recognition to the engineering role?	☐	☐	☐
Will I be working and interacting with other talented professionals in my field?	☐	☐	☐
Will my accomplishments be acknowledged, appreciated, rewarded?	☐	☐	☐
Will I be encouraged to seek more challenge and responsibility?	☐	☐	☐
Will the company pay for advanced training in technology and management?	☐	☐	☐
Can I pursue my own career goals within the company framework?	☐	☐	☐
THE LONG RANGE PICTURE			
Where will you be professionally in 5 years?...in 10 years?			
Are there plenty of opportunities for rapid advancement within the company?	☐	☐	☐
Does the company encourage engineers to assume positions of authority?	☐	☐	☐
Will I be allowed to move into those engineering areas that interest me most?	☐	☐	☐
Can I choose my own career path—into technological leadership or executive management?	☐	☐	☐

One Company to Evaluate

At Racal-Milgo, we're looking for capable communications hardware and software people to join our engineering team. Our success has created needs at every level, from entry to top management. We have a lot to offer you.

The mainstream of our business is data communications—where today's action is. We're a pioneer, and a recognized leader in the field. Our state-of-the-art product lines include modems, multiplexers, data encryption, and systems for sophisticated network control and performance assessment.

We're proud of our growth—$64 million in sales two years ago, $80 million last year, and over $100 million this year—and we're still growing. Applied research and technology keep us on the leading edge in data communications; our engineers face some of the industry's most challenging (and rewarding) responsibilities.

Racal-Milgo is a great place to work. We encourage our technical people to think creatively, to turn their innovative ideas into successful products—in an atmosphere of friendly, professional teamwork. We provide them with one of the nation's most advanced engineering facilities. Our salaries and benefit programs are among the best in the business.

We're located in suburban South Florida, one of the growing new electronics centers in the sunbelt. It's an international area, gateway to Latin America, blessed with a pleasant climate year-round. There are excellent cultural and entertainment opportunities, plus swimming, diving, boating, sport fishing, golf, tennis, and all the other benefits of a cosmopolitan resort. There's a wide choice of employee clubs to introduce you and your family to new activities. And if you're interested in furthering your professional or business related education, we'll pay for your coursework at any of the major universities nearby.

At Racal-Milgo, we're experiencing dynamic growth, and we need good people at all levels. The working conditions are excellent...advancement and rewards come fast...and our new two-track career program lets you decide whether to rise to the top on the technical side or to move into management. (Our president and board chairman are both EE's.)

We're looking for the best. If you are too, let's get together. I hope to personally welcome you aboard. Send me your resume today; no letter required. You'll receive a prompt reply.

Ed Hilpert

Ed Hilpert
Vice-President, Engineering

Racal-Milgo™

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8600 N.W. 41st Street Miami, Fl. 33166

Data comm: LSI and fiber-optic components will help networks channel the flow

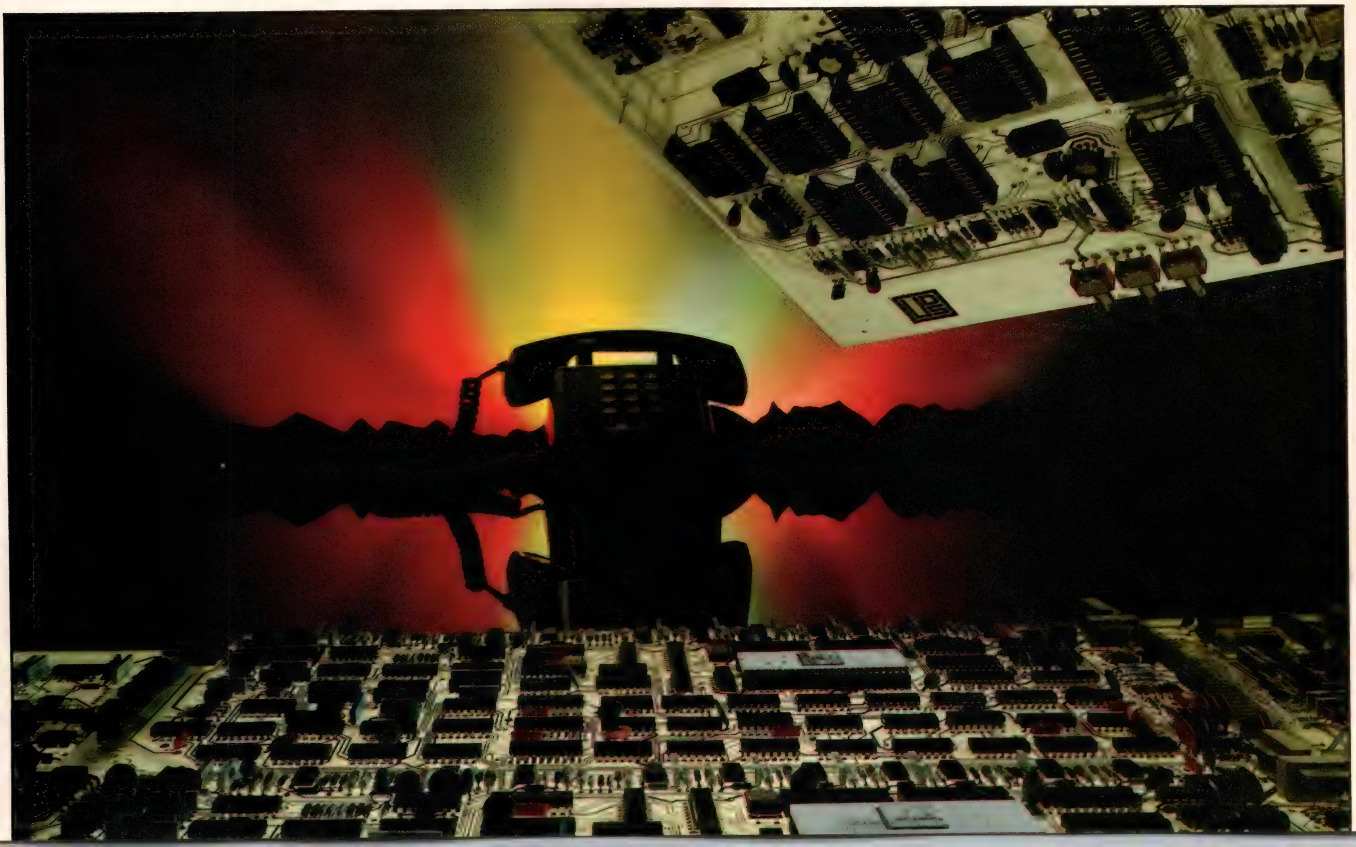
Telecommunications and data processing, two major sectors of electronic technology that started out going separate ways, have come together to form a third major sector—data communications. While digital central offices and PABXs have become essentially message-switching computers, reliable communications systems have become a must for distributing data processing. Digital data from intersite computers and far-flung terminals now begin and end in an analog form compatible with local-distribution telco loops; meanwhile, analog voice signals travel along long-haul trunks in noise-resistant digital form.

Up to now, specialists familiar with networking protocols at the processing side and channel characteristics on the transmission side have been able to develop devices that end users could piece together into simple links and even into rudimentary data-comm networks. However, advancing technology has overrun this simple approach. The proliferation of ever-smarter terminals at the periphery of ever-growing data-accumulation systems, coupled with the tendency to distribute overall processing loads throughout a system, has spawned high-density data traffic over complex network configurations. In turn, integrating intricate communications and data-processing capabilities into inexpensive and reliable LSI chips has bred equipment for handling the swelling data traffic—even as other LSI-based equipment spurs on traffic increases.

To keep abreast of this widespread growth, some end users are demanding that the required hardware and software for transparent communications be built into terminals and processors. Some users go even farther by ordering turnkey data-comm networks from a higher level of OEM: the supplier of installed, operational—and total—systems.

For all these reasons, the users of technology again must turn to the designers for solutions. To help designers provide answers, the Communications issue of ELECTRONIC DESIGN presents comprehensive coverage of the following leading-edge developments:

- Data-comm components that OEMs can integrate into end-user products to break the distributed-data log jam, and usher in the office of the future
- Fiber-optic components for high-capacity transmission with minimal interference
- LSI chips for filtering codec signals cleanly at low power
- LSI chips that program on-line to handle most popular synchronous data-comm protocols.



Courtesy Universal Data Systems

Data-comm-equipment specialists match the hardware with the transmission

Sid Adlerstein, Communications Editor

Designing transmission systems to carry data farther than required by the usual specs for interfacing data terminals to data-circuit terminating equipment is best left to specialists. Specifying the lines and the driver/receiver sets is simple enough for data rates and distances spelled out in the EIA's RS-232C or its CCITT counterpart, V.24. Even the new and more powerful RS-449 can be handled by experienced circuit designers. But sending data across the world, much less miles away, is another matter. For the more ambitious communications functions that end users keep demanding, designers of data and word-processing equipment must turn for help to data-comm-equipment designers.

As it turns out, the specialists all along have been creating a rich crop of products intended for the end users themselves. As a result, OEMs can choose from data-comm hardware that is varied, well-designed and cost-effective. The real challenge is to select the form, fit and function of data-comm hardware that best suits the particular equipment. When all three don't fill the bill exactly, many data-comm manufacturers offer redesign services.

However, one thing not usually open for redesign is the transmission medium. So it's important to choose the right one the first time.

Several media are prime candidates for data transmission, foremost being the switched, direct-distance-dial (DDD) public telephone network. Next in popularity are leased voice-grade lines, with or without conditioning. Private wire and cable lines are also important. Other media include fiber optics—whose use is blossoming—wideband analog telco services, the Bell System's Dataphone Digital Service and proposed Advanced Communications Service, and soon-to-be-initiated satellite-based services.

Once the medium is determined, it's up to OEMs to provide the access hardware. Such hardware includes:

- Modems for DDD or leased voice-grade lines
- Limited distance modems, modem eliminators and line-driver/receiver sets for private wire
- Rf modems for coaxial cable
- Fiber-optic modems for fiber links.

But beyond basic transmission—beyond modems—the need is growing to design efficient systems and manageable data-comm networks. Given this responsibility, the data-comm-equipment designer can turn to several building blocks for assistance:

- Multiplexers combine separate data streams into a composite signal for transmission over one channel. They also demultiplex, or separate, the original streams from the composite at the receiving end so that the connections from data sources to data sinks are transparent.
- Data concentrators (or statistical multiplexers), error controllers and part-sharing units strengthen the network's efficiency and reliability.

But once the overall network architecture is structured, another class of hardware is needed to help CPUs maintain it:

- Front-end processors—often minis associated with host mainframes—oversee communications protocols, message handling, code conversion and error control, and can even control special-purpose terminals.
- Network controllers often include the maintenance and reporting functions that help keep a data-comm network up and running.

The message is clear. The buck stops at the data-comm-equipment designers. And they have the tools to be ready.

Modem performance comes in many packages

Modems, which convert digital data signals to analog form for telephone transmission, offer OEM designers a rich variety of packaging, performance and functions. Sets of dual-in-line, thick-film hybrid modules, PC-board mounted modules, potted modules and cards containing microprocessors and powerful custom LSIs are all available.

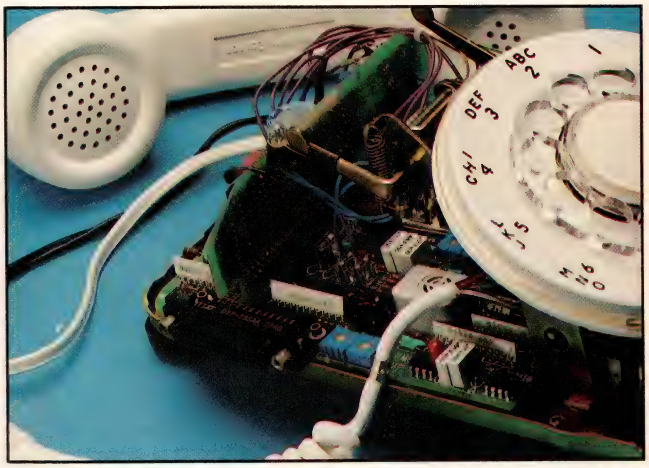
While transmitter and receiver modules are the best way to go for prototyping and small-quantity applications, complete PC-board assemblies using the modules require less of a designer's time in developing, testing and engineering support. Derivatives of encased units are also available—several end-user modem manufacturers have simply stripped the cases, and sometimes even the power supplies.

Using card-mounted modules and additional on-board circuitry usually involves a one-time charge for engineering. For runs of 100 to 250 units, however, buying board-level modems assembled in the main from available modules proves less expensive than buying just the modules, and then mounting them.

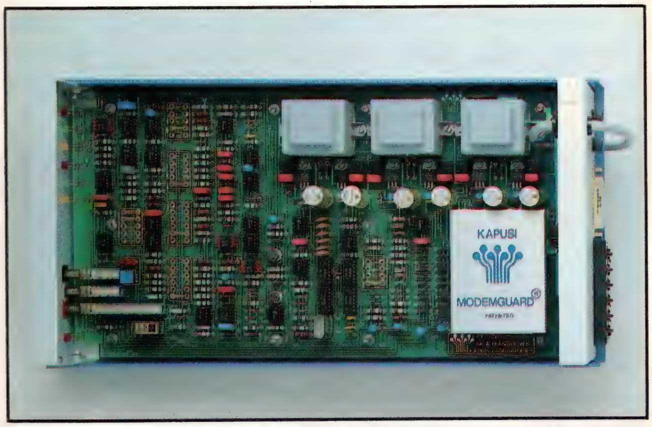
For quantities of 500 and over, suppliers like Racal-Vadic prefer to mount all the components directly on one PC board. Universal Data Systems apprises OEM modem customers of the features it has incorporated into its over 2000 previous designs. After the customer selects what he needs from this catalogue, or "menu," UDS extracts the appropriate circuitry from previous designs and whips up an appropriate prototype.

Module sets divide logically into transmitter and receiver packages, with the transmitter containing oscillator, bandpass filter and frequency-selection circuits, and the receiver containing bandpass-filter, limiter, discriminator, slicer and carrier-detection circuits. In addition to the basic transmitter and receiver, modems usually include a transformer for coupling to the line (line hybrid), and controls for such auxiliary functions as automatic call answering and/or originating as well as half-duplex operation.

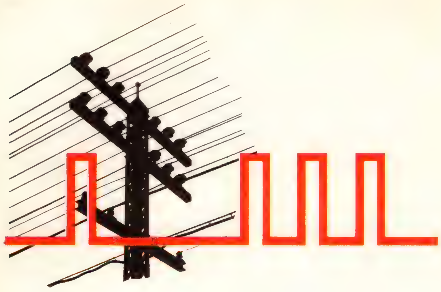
Although such circuits have not yet yielded to total monolithic integration, thick-film hybrid circuits are



Racal-Vadic's ModemPhone, with a built-in full-duplex Bell 103/113-compatible modem, allows direct connection to the telephone line, thus eliminating the extra modem box and the need to rent a separate telephone set.



Data-transmission stretching as far as 40 miles and asynchronous rates up to 19.2 kbits/s come protected from current surges and overvoltage due to line crosses or lightning in Kapusi Laboratories' DT19.3 data transceiver on a board.

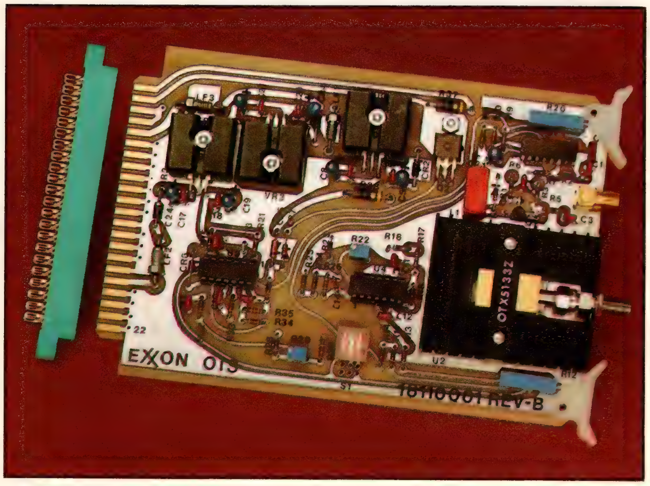


being increasingly used to reduce size and simplify package design. For example, Cermetek provides transmitter and receiver building blocks in thick-film hybrids housed in dual-in-line packages. A set of such miniModem modules (the 1200 series) can, in fact, provide 90% (estimates the company) of the functions for three popular data-set types: two 300-bit/s sets—one Bell-compatible, the other CCITT-compatible—and a 1200-bit/s set that is compatible with both the Bell 202 and the corresponding 1200-bit/s CCITT equipment.

The Bell-compatible 300-bit/s modem uses six modules in the company's 1200 family—modulator, transmitter filter, line hybrid and squelch, receiver filter and soft limiter, demodulator, carrier detector—along with one of three mode-selector modules: for originate-only, answer-only or originate-and-anwser sets. These modules help make up modems that are compatible with Bell System 113 A/B, 103A2/F and 108A/C data sets, among others.

The CCITT-compatible 300-bit/s modem also uses six 1200-family modules for the same functions but one of only two mode selectors—for originate-only or answer-only sets. Originate-and-answer mode sets use four other 1200-series modules: programmable modulator, receiver filters, demodulator and transmitter filters.

Another set of mini Modem modules, the 1600 series, provides eight modules for an originate-only modem and nine for an answer-only modem. Moreover, these



Does 275-Mbit/s transmission sound futuristic? This diode-laser-based fiber-optic transmitter module from Optical Information Systems accepts ECL data at that rate.

Fiber-optic transmission works now

No longer must designers wait to reap the advantages of fiber-optic transmission—the components for cost-effective data-transmission systems are available now for limited distances. Fiber-optic transmission gives freedom from noise caused by electrical and magnetic interference, high bandwidth-distance products, electrical isolation and typical data-transmission rates of 20-Mbits/s and higher. Often, the same modems, data links, modular transmitters/receivers and multiplexers will work for OEMs (who design the electrical-optical components into end-user equipment) and for system-level designers (who combine standard products into networks).

The simplest fiber-optic modems for system makers are boxes (either stand-alone or rack-mountable) that are plug-compatible with standard, RS-232C, asynchronous and synchronous, limited-distance, wire-line modems. These plug-compatible units make conversion from a metal-wire to an optical-fiber transmission system a matter of simply replacing the modems and cables. The devices shake hands using the same standard control signals and often provide the same self-testing functions offered with conventional modems.

For OEM communications, stand-alone or rack-mountable data links support high-speed serial data communications (20 Mbits/s) over processor-to-processor or links (limited to kilometer distances). The clock and data are usually transmitted together over the link by Manchester-type coding.

Modular optical-electronic converters for OEMs come in more varieties than almost any other components. Low frequency, short-distance units mate with low-cost but lossy plastic or plastic-clad silica fibers. Sophisticated combinations of circuitry, emitter and detectors carry up to 10 Mbits/s of asynchronous data over graded-index fibers in links. The installation of graded-index fiber-optic links before they are needed prevents the capacity problems that all data-transmission links eventually suffer.

For easy integration into existing equipment, fiber-optic link modules operate with the power-supply voltages most commonly used in data-handling logic: 5 or ±12 V. Their height allows simple mounting on p-c boards that must fit normal 0.5-in. spacings.

Richard McCaskill
Product Manager
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modems can operate full-duplex at 1200 bits/s in the forward direction and 150 bits/s in the backward direction, for control. Not only that, but these 1200-bit/s units are compatible with both the Bell 202 and the corresponding CCITT 1200-bit/s sets.

In addition, eight modules in the 1600 series can be put together to form a 202/CCITT-compatible, answer-and-originate modem. Though the modules and the additional external components take up only 5 x 6 in. of board space, the performance is respectable: 0 to 70-C operating temperature, −45-dB receiver sensitivity, ±10-Hz frequency tolerance, carrier delay of 40 ±20 ms to operate and 12 ±6 ms to release, 45-dB dynamic range and 8% worst-case pulse-to-pulse jitter. All this adds up to a bit error rate of 1 in 10^5 at a 3-dB signal-to-noise ratio when operating full-duplex over switched voice-grade telephone lines.

Complete units

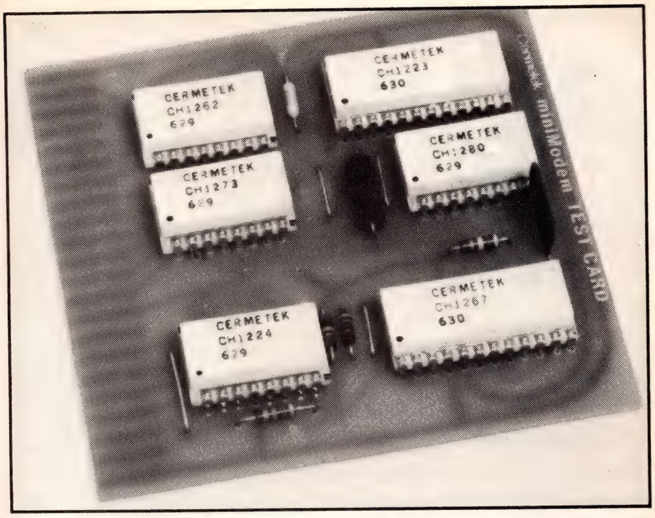
Another set of modem modules, the R24 from Rockwell, divides into more complete functional units: The R1 and R2 modules make up a complete receiver; the T module alone is a transmitter. A modem configured with all three modules can operate in the half-duplex mode over two-wire circuits, and full-duplex over four-wires. In addition, the three modules take up just 25 in.^{2} Originally introduced by Rockwell in potted versions, the modems now come unpotted and bare on PC boards. The tradeoff is very attractive —one plastic covering for lower cost, better accessibility, lighter weight and less power dissipation.

On-board LSI MOS chips help perform differential phase modulation in the transmitter and coherent phase detection in the receiver that meet the high performance levels required for compatibility with Bell 201 B/C and CCITT V.26 sets operating at 1200 and 2400 bits/s. In addition, the transmit and receive modules, by operating independently, are the only modules needed for simplex operation (receive or transmit only).

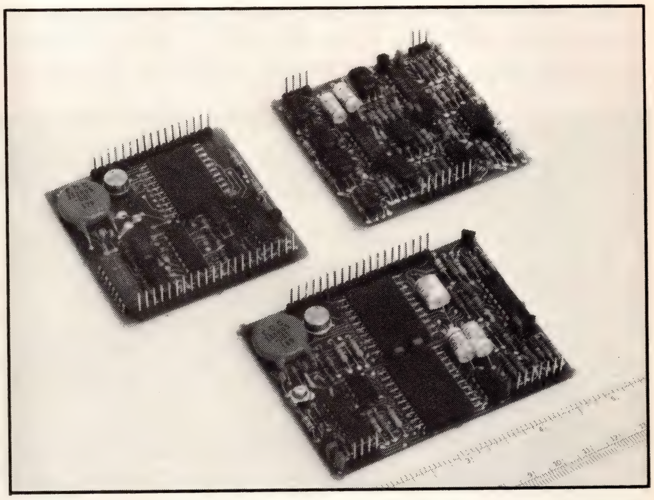
In general, R24-module modems can be configured into many versions through the digital controls at the module interfaces. These controls can be operated via software-generated signals from a CPU, thereby changing the modem while it is on line.

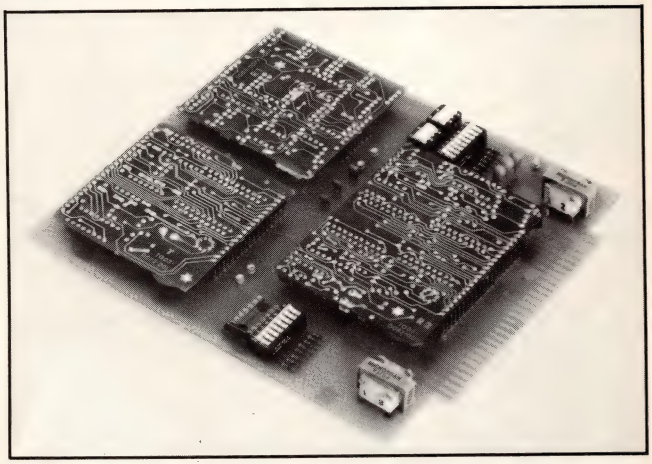
For example, the transmitter's output-signal level can be set from − 1 dBm to −15 dBm in eight steps, with 12 turn-on sequences that vary the sending-response time from 6.67 to 800 ms. Scrambler and descrambler circuits can be inserted selectively into the modem's transmitter-to-receiver path to ensure that the transmitted-data spectrum evenly spans the allocated line bandwidth (800 to 2800 Hz). The randomizing action of the scrambler minimizes pattern-sensitivity problems that can arise due to simple fixed or periodic sequences of encoded data.

A graph of typical R24-modem characteristics shows that inserting the scrambler reduces the bit-error rate at a given signal-to-noise ratio. The

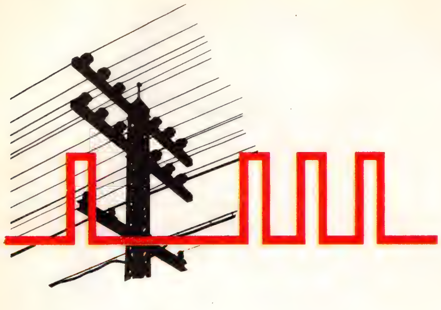


FSK modems operating at 300 bits/s can be assembled from six hybrid-constructed mini Modem modules by Cermetek, and some additional interface circuitry. Modems made from these DIPs are compatible with each of Bell's 100-series data sets.





Three modules on a card make up a 2400-bit/s modem, compatible with the Bell 201 B/C data sets. One module in the Rockwell R24 set is for the transmitter, the other two for the receiver. The only other components needed on the board are two isolation transformers and clamp-selection switches.



scrambler-descrambler circuits can also be used to test the overall operation with a 127-bit pattern.

Another option, this one strappable, normally places a fixed compromise-delay equalizer in the receiver. But this circuitry can also be placed into the transmitter, or even bypassed. When in the circuit, however, the equalizer improves the performance over unconditioned 3002 lines by compensating for the mean range of group-delay distortions generally encountered in the U.S.

For multipolling operations, the receiver can be rapidly resynchronized via interface signals to keep pace with sequences of incoming messages. For direct connection to a leased line in the U.S., a transformer is the only external component needed.

Generally, connecting to the switched network requires either FCC-registered protective circuitry or a data-access arrangement (DAA). Rockwell offers a registered protective device to support the R24.

μPs come aboard

One nice thing about PC boards is that they can hold so many different things—and surely a milestone in the development of modems has been to incorporate microprocessors into OEM-modem cards. With the circuit sharing made possible with programming, extremely complex subsystems now fit easily on standard-size cards.

In addition, OEMs find that they can harden their equipment designs, confident that the OEM modem within will not change in size, shape and probably not even in cost when more functions are added or modes of operation changed. Simple PROM-chip changes should handle many upgradings. What's more, customized modems and design changes can be put through in less time at lower cost than possible with

PSK shows up FSK at high transmission rates

Modems use one of three popular modulation schemes—amplitude (AM), frequency (FM) or phase (PM)—to convert digital data into analog form for transmission over telephone networks and to reconvert it at the receiving end. For data transmissions exceeding 1200 bits/s, only PM will provide the necessary performance.

Amplitude modulation changes the amplitude of a fixed-frequency carrier and frequency modulation changes the frequency of a fixed-amplitude carrier, each on a one-to-one basis with every change in the logic value transmitted. In both AM and FM transmission, therefore, baud rate equals the number of bits/s. Most FM modems using the frequency-shift keying (FSK) method handle data rates up to 1200 bits/s.

Phase modulation shifts the phase of a fixed-amplitude, fixed-frequency carrier by a discrete amount in response to a pattern of bits (phase-shift keying). The baud rate can be one-half, one-quarter or one-eighth of the rate in bits/s. PM modems use PSK for transmission rates of 2400 bits/s and higher, as well as for full-duplex operation at 1200-bits/s.

Why is FSK unsuitable and PSK necessary for data rates over 1200 bits/s? FSK modems can transmit and receive on two channels simultaneously at data rates below 600 bits/s. The bandwidth is 1070 to 1270 Hz and 2025 to 2225 Hz. This 200-Hz spread for each channel is well within the restrictions of voice-grade telephone lines (300 to 3300 Hz, for a total spread of 3000 Hz).

At data rates of 600 to 1800 bits/s, the standard FM bandwidth is 1200 to 2200 Hz, giving a spread of 1000 Hz for each band. Although this spread also seems to fit within the restrictions, the voice-grade telephone line is narrower than it appears: Attenuation is severe below 1000 Hz and the frequency range above 2400 Hz is reserved for tone signaling—leaving a total effective bandwidth of just 1400 Hz. Thus, at transmission rates of 600 to 1800 bits/s, FSK modems can either send or receive, but not simultaneously.

Modems that use di-bit PSK (DPSK) operate on 2 bits at a time, modulating or demodulating the carrier phase accordingly. Thus, the baud rate is half the bits/s, and the frequency spread is cut substantially. Full-duplex operation is possible at 1200 bits/s or 600 baud; the typical carrier frequency is 1150 Hz for transmitting and 2250 Hz for receiving. DPSK is also used for data rates of 2400 bits/s. However, full-duplex operation is no longer possible, because the low-channel carrier frequency (1150 Hz) is too close to the baud rate (1200 baud) and information could be lost.

At higher rates—4800 and 9600 bits/s—modems group together more bits at a time, and produce smaller phase shifts for each bit combination. Modems handling 4800 bits/s use 4-level encoding and modems handling 9600 bits/s use 8-level encoding. Four (or eight) bits are examined at a time, and each possible combination is converted to and from a predetermined phase shift.

David L. Peters
Marketing Manager
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Sunnyvale, CA

Telephone lines speak out for compatible modems

Modems translate properly only when the demodulation and modulation schemes match at each end of a telephone line. The factors that may jeopardize compatibility are:

- The carrier frequency of the modem
- The design of the scrambler
- The assignment of signal space.

Commonly used modems can send data at 1200, 2400, 4800 and 9600 bits/s. Incompatibility is rare at the two lower speeds. Of the four, 2400 bits/s is the most popular rate for real-time interactive networks; the analog transmission uses 4-Ø quadrature amplitude modulation, conforming to the international specification CCITT-V.26.

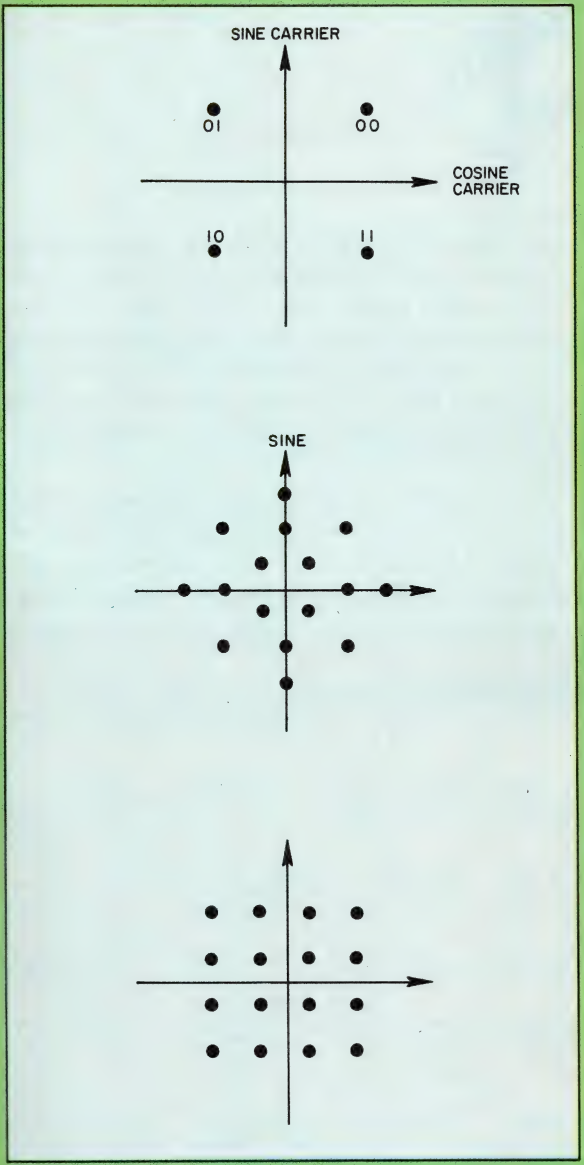
Most 2400-bit/s modems are on-line compatible with most 1200-bit/s modems. The slower-rate sets are a good deal less expensive for data transmission. The common modulation scheme at 1200 bits/s is FSK; it results in robust or forgiving receivers that can translate message signals despite variations in modulated signals.

Incompatibility between modems is most likely to occur at the higher data rates. Without intermediate frequency translation, modems can communicate only if they operate at the same carrier frequency. The carrier frequencies at 4800 bits/s and at 2400 bits/s are usually identical—1800 Hz. However, some of the faster modems use a 1700-Hz carrier; and at 9600 bits/s, the variation in carrier frequency is even wider —1650 to 1800 Hz.

Scrambler designers also affect compatibility. A scrambler combines incoming digital data with a random-seeking data sequence that is internally generated. The scrambler optimizes the modem's performance by ensuring that it always uses the full bandwidth of the telephone channel. Incompatibility between modems may arise though variations in the length of the shift register that holds the random data and through differences in the location of the taps that provide randomizing feedback. Moreover, the receiver must have a decoder that accepts the scrambled input. A scrambler with a 7-bit shift register generates patterns that a 9-bit shift register cannot unscramble.

Signal-space assignment involves the exact encoding of digital information as an analog signal. For 2400, 4800 and 9600 bits/s, the most common technique is quadrature amplitude modulation (QAM). Some high-speed modems use vestigial sideband (VSB), but QAM is generally held to be superior. QAM uses two carriers, sine and cosine waves, both at the same frequency.

At 2400 bits/s, data are transmitted 2 bits at a time, requiring four digital assignments (see top figure); at 4800 bits/s, eight data assignments are needed; and at 9600 bits/s, 16. The signal-space assignments may differ in different modems. The bottom figures show two possible phase assignments at 9600 bits/s; the cosine carrier is represented by the horizontal axis and the sine carrier by the vertical axis. The center figure represents the CCITT-V.29 standard, and the bottom shows the use of signal space in ATT's 209 modems. The two are clearly incompatible.



One way to avoid incompatibility is to design an entire private-line network using the same type of modem throughout. A preferable trend, giving more flexibility in light of the growth of interactive data communications, is toward the adoption of the CCITT standard, which would ensure hardware compatibility for the future.

David Lyon
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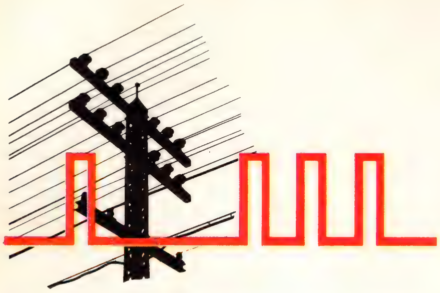


hardware only.

Microprocessor-based OEM modems operate in just about every popular data-transmission range from 0-to-300 up to 4800 bits/s. The SC212 from Ven-Tel operates at 300 bits/s, using FSK modulation, and at 1200 bits/s, using PSK modulation. The two modulation schemes, the unit's carrier frequencies and its control functions are all compatible with the Bell 212A data set.

Operating synchronously or asynchronously in the full-duplex mode over direct-distance-dialed (DDD) or leased lines, the SC212 offers both answer and originate capabilities. Diagnostic features include loopback and self-test functions.

The unit carries FCC registration for direct connection to the DDD and supports RS-232C and 20-mA current-loop interfaces. The μP-based design incorporates Bell System Series-100 communications protocols that facilitate rapid changeover to 1200-bit/s operation from the lower speed, without major changes in the operating systems. Note that the SC212 must wait 50 ms between receiving a Request To Send (RTS) and raising its Clear To Send (CTS) response. This means that at the least 50 ms must pass (during which time, no data can be transmitted) at the start of a message. Ordinarily this is not excessive.

For operation at 2400 bits/s, Intertel offers the μP-based M2400, whose differential phase-shift keying (DPSK) modulation scheme, carrier frequency and control system make it compatible with the Bell 201 data set. The M2400 operates synchronously in full-duplex mode over four-wire DDD or leased lines, offering both answer and originate capabilities.

The imbedded μP contributes heavily to the board's extensive catalog of diagnostic features, which include both analog and digital loopback, a self-test function,

Representative wire-line data sets

Manufacturer	Model No.	Data rate (bits/s)	Bell compatibility	Timing	Connection modes	Circuit needed (wires)	Circuit types	Duplex communications modes	FCC registration	Test features
Avanti	2100	2.4 K to 230.4 K		Sync	Answer/ originate	2, 4	Unbalanced twisted pairs, 50Ω coax dc continunity required	Half or full		Loopback, internal test generator
Cermetek	103A2	0 to 300	113A/B, 103 A2/F, 108 A/C	Async	Answer/ originate	4	DDD (with DAA) unconditioned leased lines	Full		Loopback, eye pattern
	202 CCITT	1200	202	Async	Answer/ originate	2, 4	DDD (with DAA) unconditioned leased lines	Full		Eye pattern
Gandalf	RM3309	1800 to 18.2 K	309	Sync	Answer/ originate	4	Private lines ac or dc coupled	Half or full		Loopback
Intertel	M1200	1200	202	Async	Answer/ originate	4	DDD or leased lines	Full	Yes	Loopback, pattern generator, self-test
	M2400	2400	201	Sync	Answer/ originate	4	DDD or leased lines	Full	Yes	Loopback, pattern generator, self-test
Kapusi	DT19.2	19.2 k	ATT Pub. 43401	Sync/async	Answer/ originate	2, 4	Ungrounded leased lines, dc-coupled voice-grade twisted pairs	Half or full		Loopback, self-test, pattern generator
Novation	4202	1200	202	Async	Answer/ originate	2, 4	DDD or leased lines (dc-coupled)	Half or full	Yes	Loopback,
Penril	300/1200	0 to 300, 1200	100 series at 300 bits/s 212A at 1200 bits/s,	Sync/async	Answer/ originate	2	DDD or leased lines	Full	Yes	Loopback, self-test
Racal-Vadic	VS300P	300	103, 113B/C	Async	Answer/ originate	4	DDD	Full	Yes	Local test
Rockwell	R24	2400	201 B/C, CCITT V.26	Sync	Answer	2, 4	DDD or leased lines	Half or full		127-bit test word generator, loopback, phase error, eye pattern
Tuck	1542	300	103 A/E, 113 B, Tuck 1530 Auto Answer	Async	Answer/ originate	2	Leased lines DDD or 3002-conditioned leased lines with less than 20% distortion	Half or full	Yes	Loopback
	1611	1200	202C/D/R/S/T	Async	Answer/ originate with options	2, 4		Half or full	Yes	Loopback
Universal Data Systems	103/113 B	300	103, 113	Async	Answer/ originate	2	DDD or private lines	Full	Yes	Loopback
	208 OEM	4800	208 A/B	Sync	Answer/ originate	2, 4	DDD or private lines	Half or full	Yes (see comments)	Loopback, random-pattern generator
Ven-Tel	SC-212	300 or 1200	212	Sync/async	Answer/ originate	2	DDD or leased lines	Full	Yes	Loopback, self-test
Versitron	CD1-19	0 to 1200 to 6.3 M						Full		Loopback

visual diagnostic feedback, a built-in test-pattern generator and the ability to help with local and remote testing. Not only that, but the flexibility provided by the μP is spurring efforts to develop optional features that should require practically no hardware changes in the equipment.

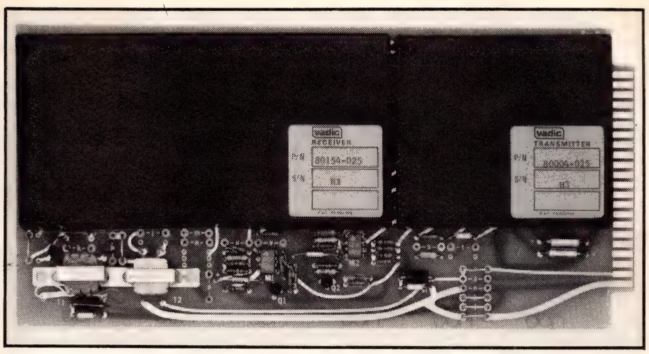
Moreover, the M2400 can be polled over the DDD network. Because DDD service extends just about everywhere, this polling capability can often be used to back up private-line operation.

High-speed operation in an OEM modem is the fruit of the μP-based design in Universal Data System's 208-OEM series of data sets. These units operate synchronously at 4800-bit/s data rates over two or four-wire private lines or over the DDD network.

UDS offers models that are compatible with both the Bell 208 A and B versions and that support the RS-232C and CCITT V.24 digital interfaces or MIL-STD-188, and TTL or CMOS line compatibility means that the 1800-Hz carrier and all the sidebands resulting from the eight-phase, differentially coherent PSK modulation are Bell-compatible.

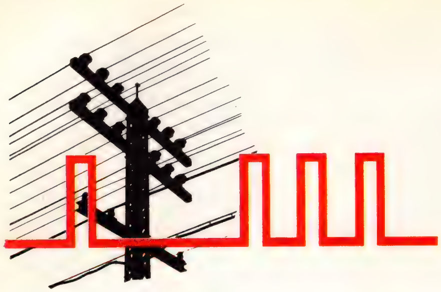
The A version operates in full-duplex over four-wire circuits and half-duplex over two-wire circuits. Because this version has no automatic-answering capability, it requires a dialer unit like the UDS 801A or C when used in a system operating on the DDD network.

The B version operates in half-duplex over two-wire circuits, and contains automatic-answering circuitry.



Transmitter and receiver modules are available separately (for simplex data comm) or in pairs from Racal-Vadic. They can also be mounted on complete modem cards that contain the necessary auxiliary circuitry.

Modulation scheme	Card size (in.)	Power supply required (V dc)	Scrambler	Interfaces supported	Delay RTS/CTS (ms)	Reverse channel control	Comments
		230/115 V ac		RS-232C/V.24, 188C, V.35, Bell 301/303			
FSK	6 modules	±14		RS-232C	265	150 bits/s	Set of six hybrid modules, assembled and tested as modem components
FSK	6 × 5	±14		RS-232C/ V.24	40 ±20		
	13 × 8 × 1	±12, +5	Yes	RS-232C/ V.24	8 or 50	For analog loop-back	Encoded waveform filtered to conform to ATT Pub. 43401; transformer coupled to work into ac-coupled lines
FSK	9½ × 11½	±12, +5		RS-232C/ V.24	0 to 150	Yes	
DPSK	9½ × 11½	±12, +5		RS-232C/ V.24		Yes	μP-based design
Baseband NRZ	16 × 8 × 3	220/110 V ac		RS-232C/ V.24, V.28	5, 30, 80, 250		6.3 miles @ 19.2 kbits/s, 24 miles @ 2.4 kbits/s; extensive V, I protection at input, output
FSK	10 × 5	24 V ac or ± 12, +5		RS-232C/ V.24	8.5 to 200	5 bits/s	Auto-dial, auto-answer features optional
FSK(300) FSK(1200)	2 boards piggyback 5 × 10	115 V ac		RS-232C/ V.24	0 (constant carrier)		Ringer equivalents: 0.7B, Telephone source drop: USOC RJ36X and RJ45S or RJ11C
FSK	5 × 8⅓ x ⅞			CMOS input, TTL output			Pulse-dialing capability
DPSK (4-ϕ)	2¾ × 3½ × ½ modules	±12, +5	V.27 or V.27 bis	RS-232C/ V.24	6.67 to 800 in 7 steps	Yes	3 separate modules: R1 & 2 = receiver, T = transmitter; total area of 3 modules = 25 in.^{2} FCC registration available with Rockwell access circuit
FSK	6¼ × 12 × 2¼	±12, +5		RS-232C or TTL	50		
FSK	8 × 13 × 1¼	115 V ac		RS-232C/ V.24	50 ±5 or 200 ±20	5 bits/s	
FSK PSK (8-ϕ, differentially coherent)	35 to 50 in.^{2} 100 to 110 in.^{2}	±12 + 5	Yes	RS-232C/V.24, TTY RS-232C/ V.24, TTL, CMOS	265 ±65 48 and 150,	5 or 150 bits/s	FCC registration available with DAA manufactured by UDS; Dial-back-up, μP-based design
FSK at 300 bits/s PSK at 1200 bits/s	7 × 9	±12, +5		RS-232C or 20-mA current loop	50		Bell 100-series comm protocols allow rapid change to 1200 bits/s without major changes in operating system, μP-based design
		115 V ac		188C, 188-114, 188-100, RS-232C, V.35, 303, TTL			Drivers and receivers on separate cards; up to 1-mile range on twisted pairs

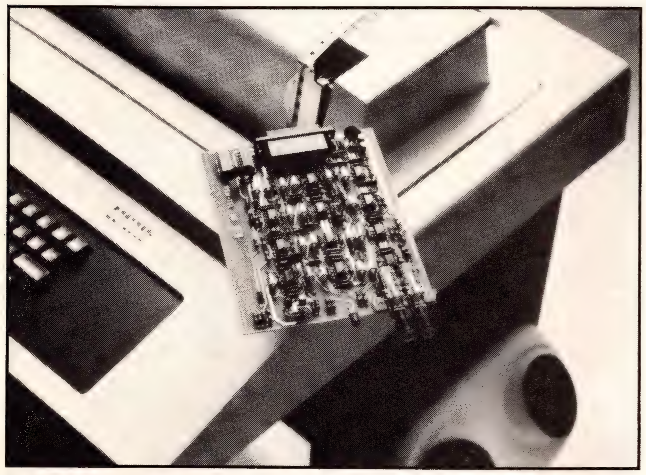


The RTS/CTS delay is strap selectable at just 48 or 150 ms—another victory for the μP-based design.

The fast circuitry allows the adaptive equalization to proceed quickly. The equalizaion, in turn, compensates for degraded lines. Another μP-derived advantage is the reduced parts count that results in a reliability jump, along with reduced power drain, and less required board space.

The 208-OEM series operates from only a +5-V supply, and takes only 100 in.^{2} for the A version and 110 in.^{2} for the B. The 208-OEM modems, or any automatic-answer modem, can be connected to the DDD network by means of UDS's approved DAAs, (1001F/D).

Racal-Vadic's latest μP-based offering, the VA3450 series, though not yet put forward in an OEM version, illustrates the potential power of processors in modem design. Series-3450 sets are triple modems that combine in one unit three separate compatibilities: Bell type 212A, Bell type 103 and Vadic VA3400. One unit can switch internally to each of the three sets of characteristics, depending on what type of modem it is communicating with.



Four data-comm operating modes can be selected using this 3½ × 4½-in. Model 120 DEC-kit OEM modem from Ven-Tel. The unit supports DEC's LA-36 writer terminal with 300-bit/s half or full-duplex transmissions in four modes: originate-only, direct-wire-EIA, acoustic-coupled or direct-DDD-connected.

OEM modems benefit data-comm designers

As modems become integrated inside terminals, processors and other end products, one problem disappears, only to call forth another: Users are freed from the difficulties of matching a separate modem with the other equipment in their data comm system; but designers of end-user equipment inherit the entire responsibility.

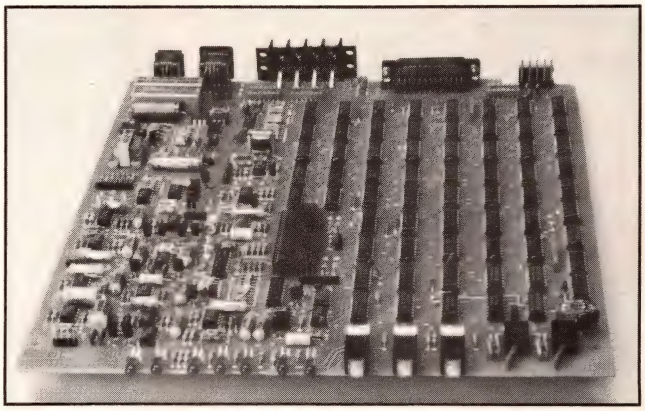
OEM modems offer a way out of this dilemma. Despite the apparent complexity of OEM modems, experienced OEM designers rarely engineer completely new circuitry. Instead, they draw on portions of previously executed designs, in menu fashion, to match the specifications supplied by the customer.

Recently, the FCC adopted Registered Protective Circuitry as an alternative to the Bell System's Data Access Arrangement, thereby increasing opportunities for using built-in dial-up modems. However, the FCC Engineering Office requires a rigid certification procedure for modem cards. Here again, modem makers often unburden their customers by obtaining the required certification themselves.

Though large manufacturers use most of the OEM modems produced, any company needing several hundred modem boards yearly can benefit from an OEM design. Compared to end-user modems, an OEM modem will cost 30 to 50% less. Much of the saving results because the OEM device shares features already in the end-product, such as the power supply.

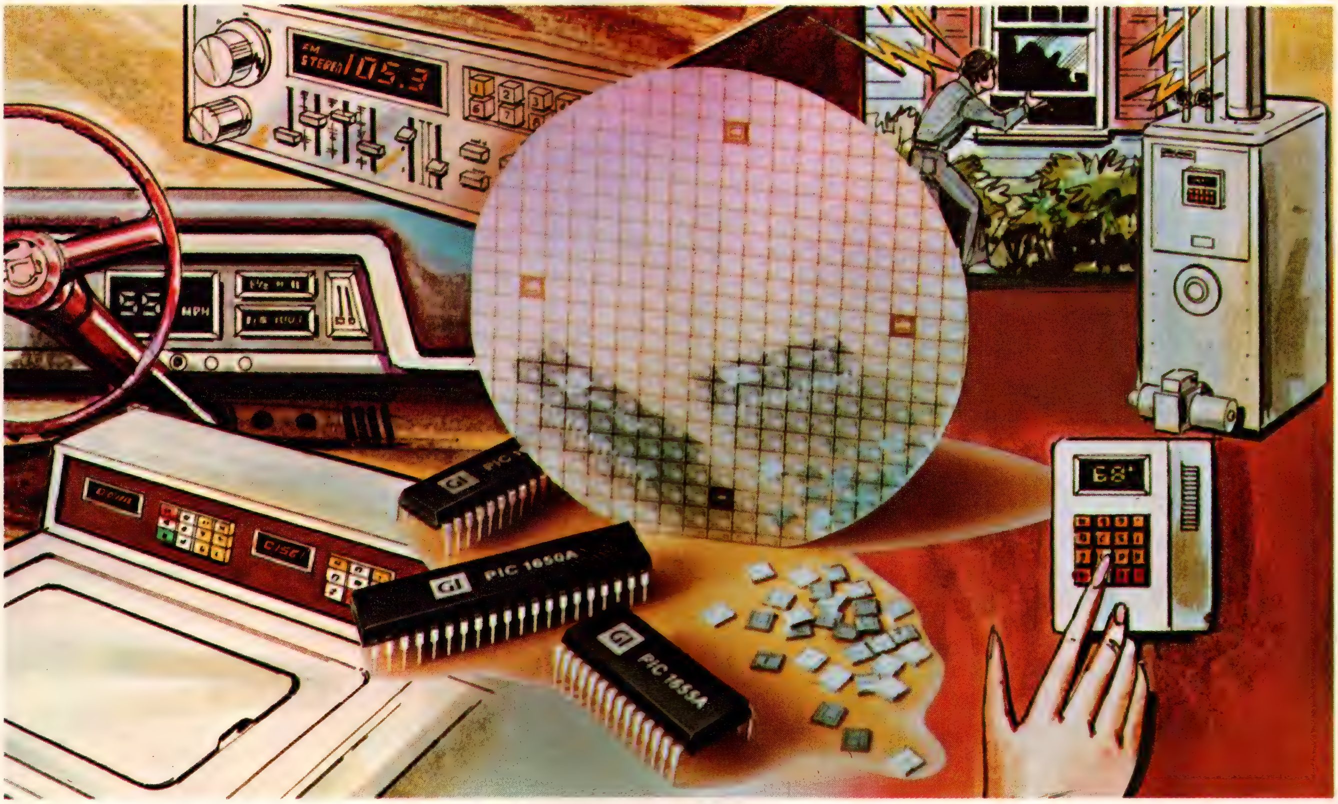
After modem engineers receive detailed specs from the customer, designers from both companies cooperate closely. The modem engineer delivers a prototype to the customer for extensive tests. After a final design is agreed upon, modem production begins, and the relationship between the supplier and specifier becomes evolutionary: As the equipment manufacturer improves his product, the OEM-modem maker ensures that the contained modem stays compatible.

George Grumbles
VP Marketing
Universal Data Systems
Huntsville, AL



Offering on-board direct connection to the DDD network, in line with part 68 of the FCC regulation, Intertel's M2400 single-board OEM modem transmits data synchronously at 2400 bits/s.

4,000,000 PICs Prove Our Point.



The point is, more designers are choosing General Instrument PIC microcomputers than ever before. And they're using them in an ever-widening range of applications; including consumer appliances, energy management systems, electronic games, security systems, keyboards, display drives, TV/radio tuning systems, and automotive dashboard instrumentation, to name but a few.

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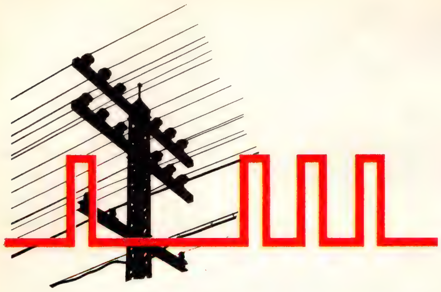
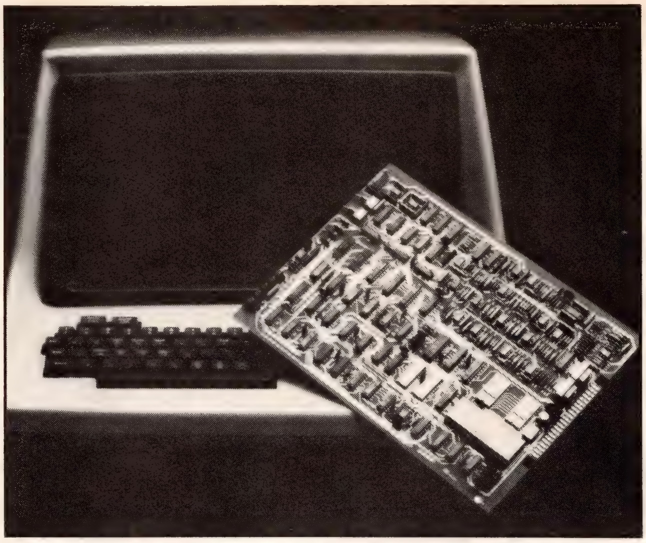




Up to 4800-bit/s data rates are handled by a board-level modem that occupies under 100 in.²—the 208 series of Bell-compatible data sets from Universal Data Systems.

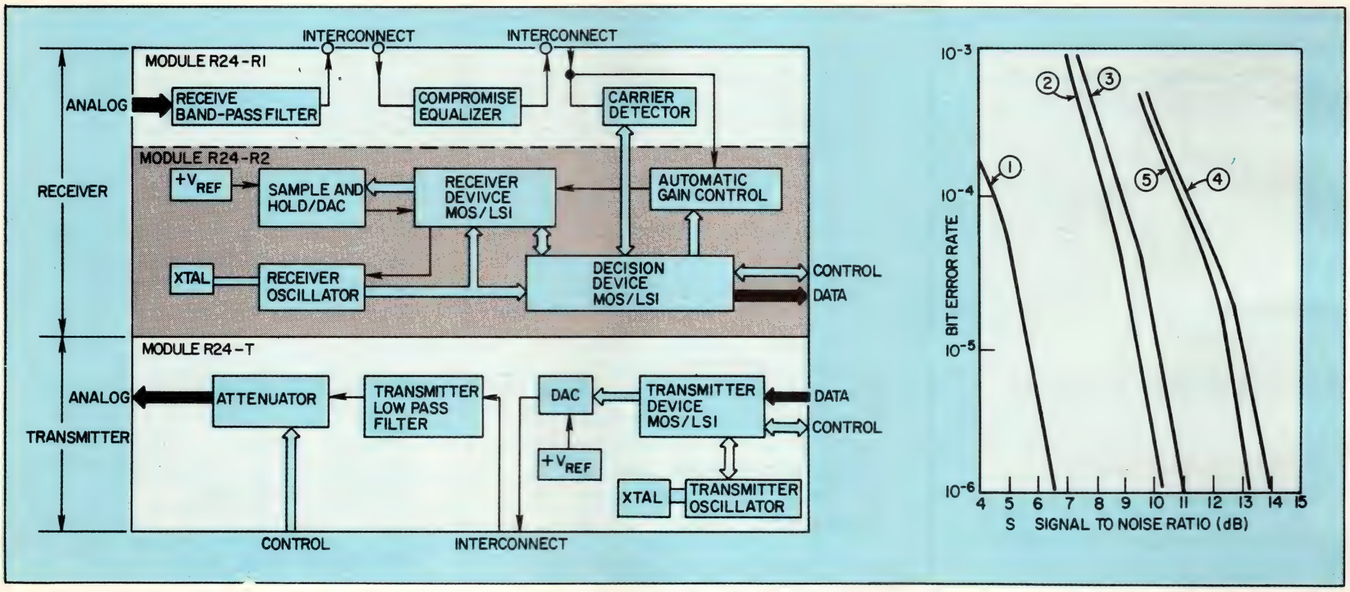
In addition to providing data-communications capability for wire lines, OEMs can include fiber-optic data-comm capabilities that are derived from either module sets or cards. Manufacturers of such fiber-optic links include Burr-Brown, Canoga Data Systems, Hewlett-Packard, Honeywell, 3M, Meret, Optelcom, RCA, Spectronics, Galite, Texas Instruments, Valtec and Versitron.

Depending on the model, many of the transmitter-receiver sets offered by these suppliers allow units that are several kilometers apart to communicate serially at up to 20 Mbits/s. These data links all use LED emitters for low cost and high reliability.

For even higher data rates, ranging up to a blazing 275-Mbit/s NRZ, Optical Information Systems offers the ECL-compatible OTX5100 series of transmitter and receiver card sets. The speed comes from the company's DI-PAC aluminum-gallium-arsenide diode-laser optical source, mounted directly on the transmitter card. Operating at 820 nm into a 5100-series receiver card, these laser transmitters have achieved successful 150-Mbit/s data communications with 1 km of graded-index fiber.

ECL-compatible OTX5100-series receivers come with either an APD or a pin-diode detector. The overall sensitivity of the APD receiver card is −35 dBm, while that of the pin-diode version is only −21 dBm. Of course, a pin-diode-based receiver card is easier to integrate into most equipment because it can work with such commonly available power supplies as ±10 and +20-V. The APD-based card needs ±10 and +300-V supplies.

In addition to modular and microprocessor-based



Transmitter and receiver sections are completely independent in Rockwell's R24 three-module modem set. For simplex send-only operation, only one module, the transmitter (T), need be used. For simplex receive-only operation, two sub-receiver modules (R1, R2) are needed. Noise performance is also shown.

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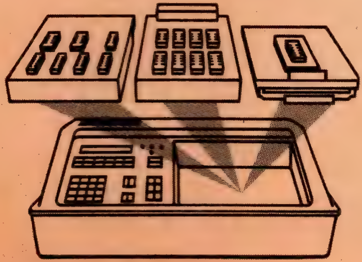
And the System 19/UniPak is easy to operate, with a minimum of operator training.

New System 19 concept is open ended to keep it state of the art. The System 19 is designed around a standard main frame and plug-in modules.



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Modules available now include the UniPak, a gang programming pak for MOS devices, and a series of programming paks for logic devices and individual PROM families.

23 communication formats including six for development systems. Development systems, computers, teletypes and CRT terminals interface easily with the System 19. The System 19 accepts micro-processor instruction codes from Motorola, Intel, Tektronix, Fairchild, FutureData and other development systems without intermediary equipment.

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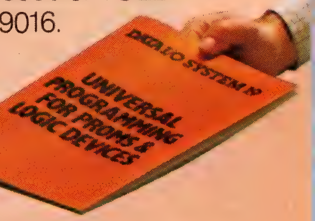

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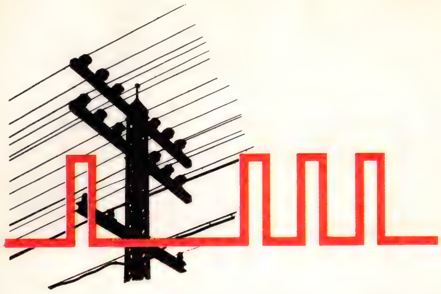
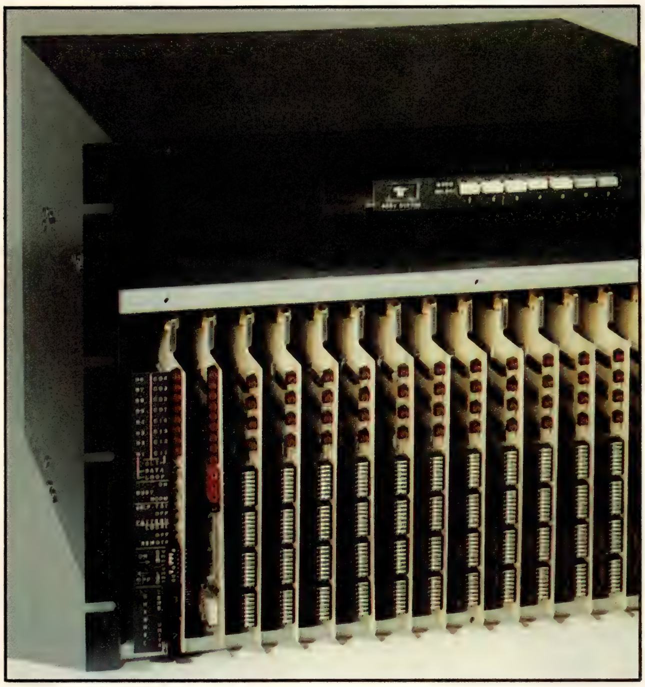


modems, many other data sets are available for OEM use. The table lists some representative sets offered for OEMs. Such manufacturers as Avanti, Gandalf, Kapusi, Tuck Electronic and Versitron offer units that can send data at high rates over limited distances. Such devices are called line drivers, modem eliminators, limited-distance data sets or short-haul modems.

Kapusi Laboratories offers a distinctive limited-distance data transceiver, the DT19.2. Both models, the L and S, offer outstanding protection from disturbances on the transmission-line crosses. The L model has the Kapusi Modemguard module mounted on it, which makes the card virtually impervious to harm from overvoltage on the four-wire lines the transceiver services.

Networks keep the data and words traveling

Look within any modern organization, and one thing becomes readily apparent: Data and word-processing equipment is proliferating—and built-in communications functions are spreading. Often located far apart, units handling these functions need to be tied together into an efficient information-transfer network. It's up to distributed-processing network designers to do the job, and the job is getting to be more demanding. Not only must transmission channels be shared but often they must operate simultaneously without interfering with each other. At this ascending level of communications design, modems are just the beginning: Multiplexers, concentrators and intelligent controllers must become a much greater part of the solution.



Thirty-two data-comm channels offering an aggregate data rate of 38,400 bits/s can be multiplexed for transmission over a single 9600-bit/s line by assigning line access only to active channels in the Supermux 680, Infotron System's statistical multiplexer. The unit adds error protection, priority control, data compression and other capabilities.

With transmission channels the most expensive sector of most communications systems, network designers are striving to get distinct units to communicate over a few actual channels (lines) as possible. That's where multiplexers come in. At the sourcing end, a multiplexer funnels data-bearing signals into fewer channels. At the receiving end, a compatible demultiplexer restores the original separate structure and places the appropriate data signals on each fanout line.

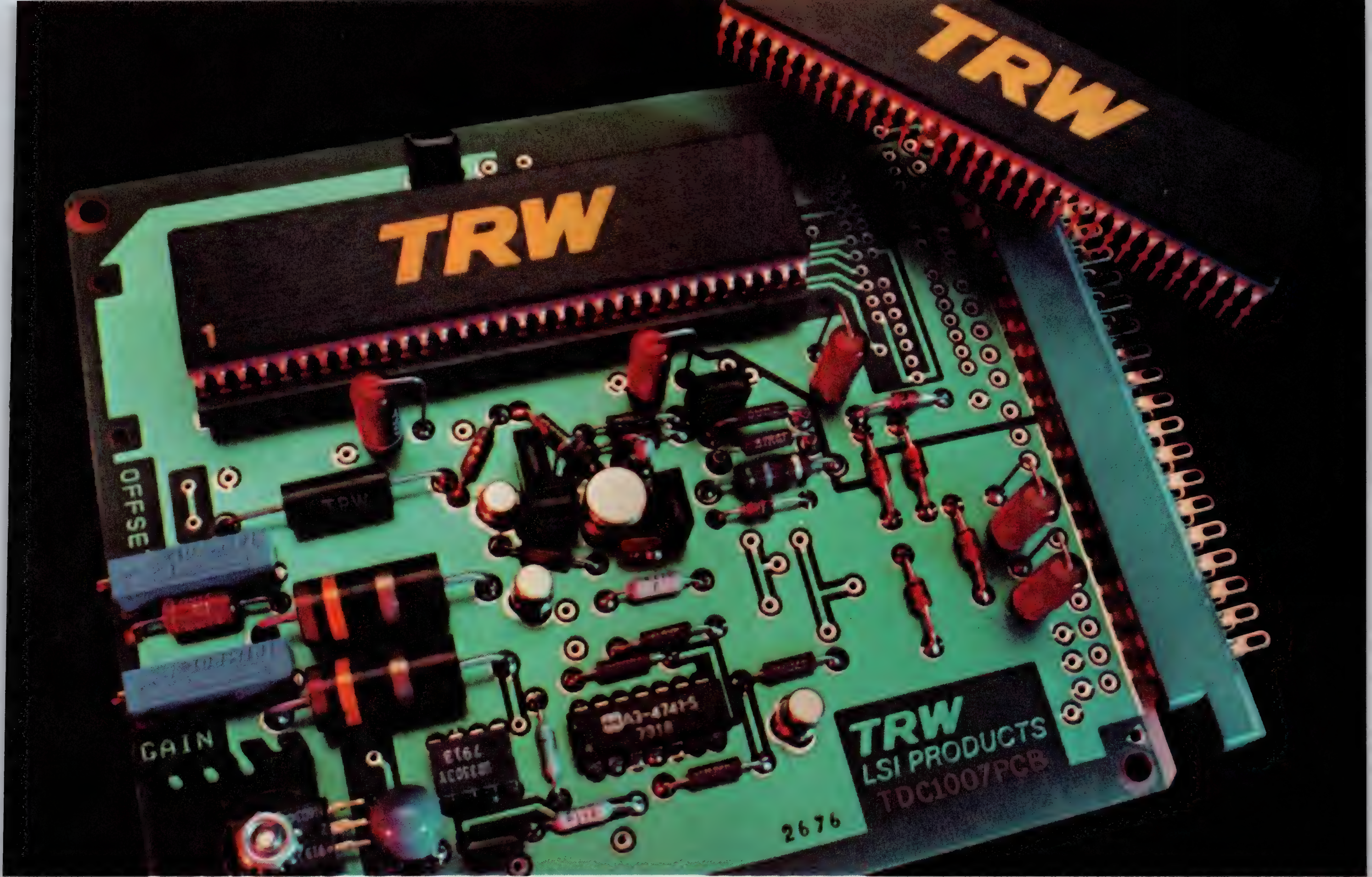
One popular way to share channels is frequency-division multiplexing. Under FDM, the total channel bandwidth is divided into subchannels that operate within allocated, nonoverlapping frequency bands. Being an analog transmission technique and thus having its signals subject to degradation from noise and distortion, FDM is best suited to the relatively short transmission distances in local data-distribution networks.

Coaxial goes local

FDM goes hand in hand with developments spawned by the cable-TV industry for its own distribution systems. In particular, the usual 300 (and now 400-MHz) bandwidths of broadband coaxial-cable systems can be used to advantage by designers of local data-distribution networks.

The link between FDM and coaxial cable—and the key to accessing coaxial nets—is broadband rf modems, which can be tuned to operate with noninterfering carriers, spaced appropriately within the cable bandwidth.

By including the modem functions, the 3200 series of FDM devices from Tuck Electronic can provide thousands of low, medium or high-speed data subchannels over standard cable-TV facilities. Taking advantage of the backward channel in FCC-approved cable-repeater amplifiers, these multiplexers can operate in full-duplex mode on one cable. Internal



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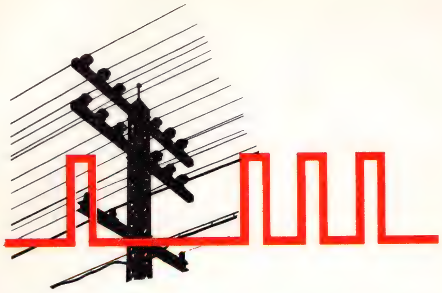
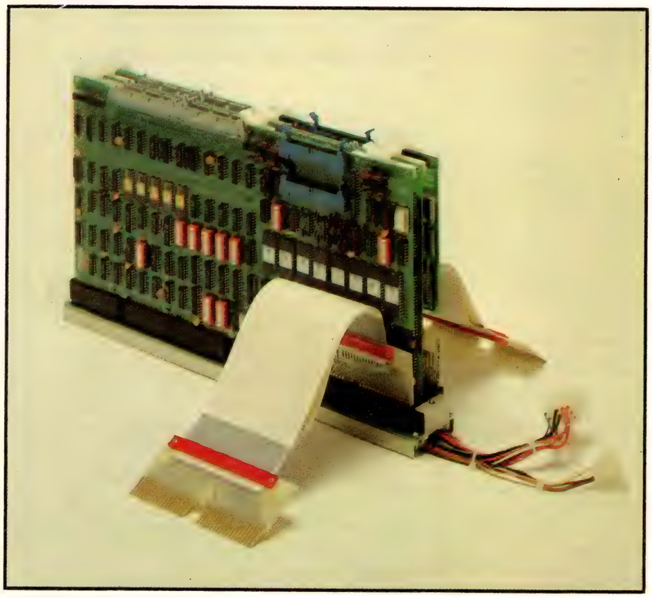


filtering keeps them either within standard TV-channel frequency spacings or within the interchannel spacing.

Another approach to local networking over broadband coaxial cables comes from Network Resources Corp., whose soon-to-be-announced SM780 frequency-agile data set is essentially a wideband microwave modem and multiplexer in one. Each unit operates, under computer or manual control, on any of 60 100-kHz-wide channels. Each channel can handle synchronous data at up to 56 kbits/s, or asynchronous data up to 9.6 kbits/s. The device's 24-MHz spectrum allows network designers to stuff 420 full-duplex 19.2-kbit/s asynchronous links for point-to-point service into one coaxial cable's bandwidth. An error rate of 1 in 10^8 should be welcome for most applications while the Ready to Send/Clear to Send delay of four clock cycles looks good for polling applications.

For very-high-speed data comm over broadband coax, Amdax (the new name for American Modem Corp.) offers a family of broadband microwave modems that operate under quadrature-PSK modulation. This scheme provides channel spacings of 0.7 Hz per bit. And in the full-duplex Model-1060 modem, in particular, the data rate is 6.128 Mbits/s.

Being analog also has advantages for FDM, which comes in handy for transmission over leased voice-grade lines. Because it is an analog technique, FDM can handle voice and data signals concurrently, as well as allow data-comm-system designers to place terminals operating at different data rates on the same lines at the same time.



Designers can add 8, 16, 24 or 32 communications lines to a DEC PDP-11 with the programmable DV/16 from Able Computer, which transfers words instead of bytes. Full control of the data sets is provided for 16 lines.

For example, card versions of Prentice's FDM equipment support half, full-duplex, or polled asynchronous data comm over either two or four-wire, 3002-type, voice-grade lines. One unit can handle single-channel data rates up to 1200 bits/s and can service as many as 25 terminals, each operating at 75 bits/s.

Tele-Dynamic's 7260 Series of FDM equipment provides half or full-duplex, point-to-point, or multipoint communications over unconditioned lines. The single-channel cards allow data rates as high as 600 bits/s to be mixed until their total fills the phone-line capacity. (Many former Tele-Dynamics data-comm products are now available from Penril). Other data-comm-equipment manufacturers, including Tuck, offer card-level FDM systems.

Another class of analog equipment for sharing data-comm facilities allows up to four terminals to use the same modem and therefore the same transmission line. The names may vary with the company—Terminal Bridge (Versitron), Modem Sharing Device (Paradyne) and Modem Multiplier (Gandalf)—but all are essentially 4:1 contention units that grant an active terminal first-come, first-served access to a modem via the RTS signal.

The Modem Sharing Device (835) and the Modem Multiplier (MM-4) lock out all but the active port until it completes its transaction—no matter how long this takes. The Terminal Bridge (TB-1) adds a time-out safety feature to the common RTS-initiated access. If a terminal exceeds one of eight preset, allotted time intervals (ranging from 250 ms to 8 s), the Terminal Bridge drops its CTS and grants the other three inputs priority. If the same terminal overruns twice consecutively, the bridge (until reset manually) automatically locks it out, granting access only to the others.

Yet another type of analog data-comm device, called a Bandsplitting Modem by Infotron Systems, allows up to four medium-speed devices to share one high-speed line. The D19600 accepts inputs from channels operating at data rates of 2400, 4800 and 7200 bits/s. Under control of an internal microprocessor, the unit then forms a 4800 or 9600-bit/s composite signal and places it on a point-to-point, full duplex, four-wire, 3002-type private line with D1 conditioning. In addition, a bit-interleaving modulation scheme, automatic equalizing and digital filtering provide a bit-error rate of 1 in 10^6 at 9600 bits/s on an unconditioned line having a 22-dB signal-to-noise ratio.

For local distribution as long as a mile on 24-gauge twisted pairs, Versitron's LDMux combines up to 15 data channels, each operating at up to 9.6 kbits/s, or seven channels, each operating at up to 19.2 kbits/s.

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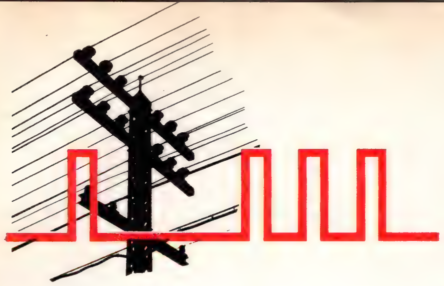


Two sets of twisted pairs are needed because the units transmit data and control signals over separate wire pairs. Hence, the LDMux comes in data and control-signal versions.

In the digital sector of communications, time-division multiplexing (TDM) extends interleaving from the bit to the character level. TDM devices combine data from various inputs by assigning each a fixed time slot on the high-speed data link. The composite stream is transmitted in real time over the high-speed link. Then the information is assembled back into the original lines at the receiving end.

Ideal for OEMs in that it comes on one PC card, Intertel's MX400 TDM device works with the company's MCS series of 4800 or 9600-bit/s modems. The card multiplexes up to four synchronous data streams, with an aggregate bit rate equal to the associated modem's, onto one speedier channel. An

Packet-switched protocols demand new diagnostics

When a data communications network uses a packet-switched protocol (like CCITT's X.25), the diagnostics must change.

The X.25 standard specifies three levels of network-access protocols (listed by their increasing requirement for intelligence):

- Electrical protocols, for physically connecting to the network
- Link protocols for logically accessing the network
- Packet protocols for establishing and maintaining virtual circuits.

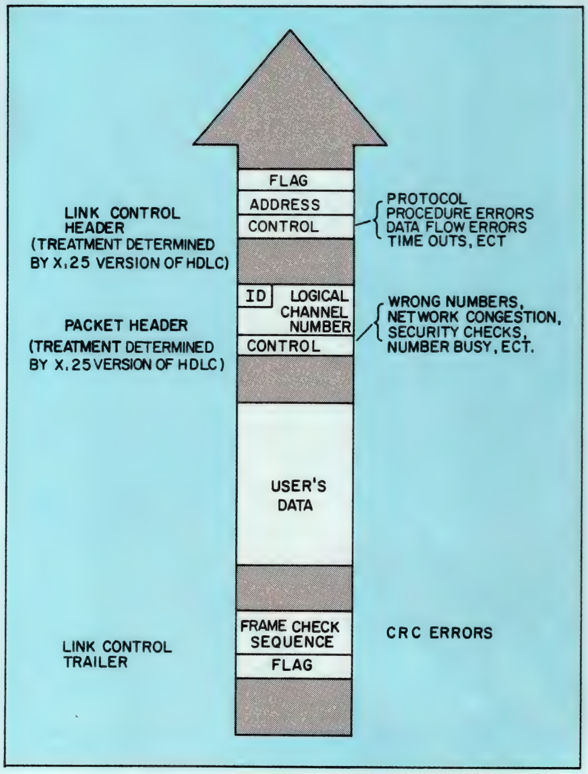
Each level is logically independent of the other two; that is, the electrical-level protocol does not exchange commands with the link or packet-level programs. Within each level of protocol, the Data Terminal Equipment (DTE) affects only the Data Circuit Terminating Equipment (DCE), the node processor.

At the electrical level (as in more conventional datacomm networks), loopback tests determine the hardware integrity; but testing is more complex than merely throwing a switch. Since the data carries control and addressing information for the link and packet levels, the data cannot be handled transparently and a higher protocol must recognize the loopback levels.

The link level automatically detects and corrects errors. Therefore, the network manager may never see them during ordinary loopback. Loopback testing must include a method for capturing and reporting any retransmissions performed.

At the link level, depending on the X.25 implementation, the protocol can offer many diagnostic aids:

- CRC Error Detection/Retransmission: The detection and recording of retries indicates the integrity of the data-link and monitors the performance of the transmission medium.
- Protocol Procedure Errors: When a protocol error is made, the link-level processing element detects the discrepancy. This can isolate failures in the DTE and DCE processors.
- Data Flow Errors: The link level also controls, data flow. Monitoring this flow can help detect memory failures, undersized buffers and processor failures. Any such fault might allow the throughput to swamp the DTE's or DCE's capacity.


FLAG
ADDRESS
CONTROL
LINK CONTROL HEADER (TREATMENT DETERMINED BY X.25 VERSION OF HDLC)
PROTOCOL PROCEDURE ERRORS DATA FLOW ERRORS TIME OUTS, ECT
ID
LOGICAL CHANNEL NUMBER
CONTROL
PACKET HEADER (TREATMENT DETERMINED BY X.25 VERSION OF HDLC)
WRONG NUMBERS, NETWORK CONGESTION, SECURITY CHECKS, NUMBER BUSY, ECT.
USER'S DATA
FRAME CHECK SEQUENCE
FLAG
LINK CONTROL TRAILER
CRC ERRORS

- Time Outs: The protocol defines certain internal counters which run out if the DTE fails to respond in a specified time. These indicate electrical-level failure at the modem or trunk level, and also flag DTE/DCE malfunctions.

At the packet level, the protocol detects network problems related to user error, rather than to hardware or software failures. Among the exception conditions captured and coded at this level are: network congestion, "wrong numbers" (such as "no DTE at that address"), billing inconsistencies (including "reverse charging not accepted") number busy and "access barred," which may be a security precaution.

Ashok K. Dhawan
Director of Product Development
Tran Telecommunications Corp.
Marina Del Rey, CA

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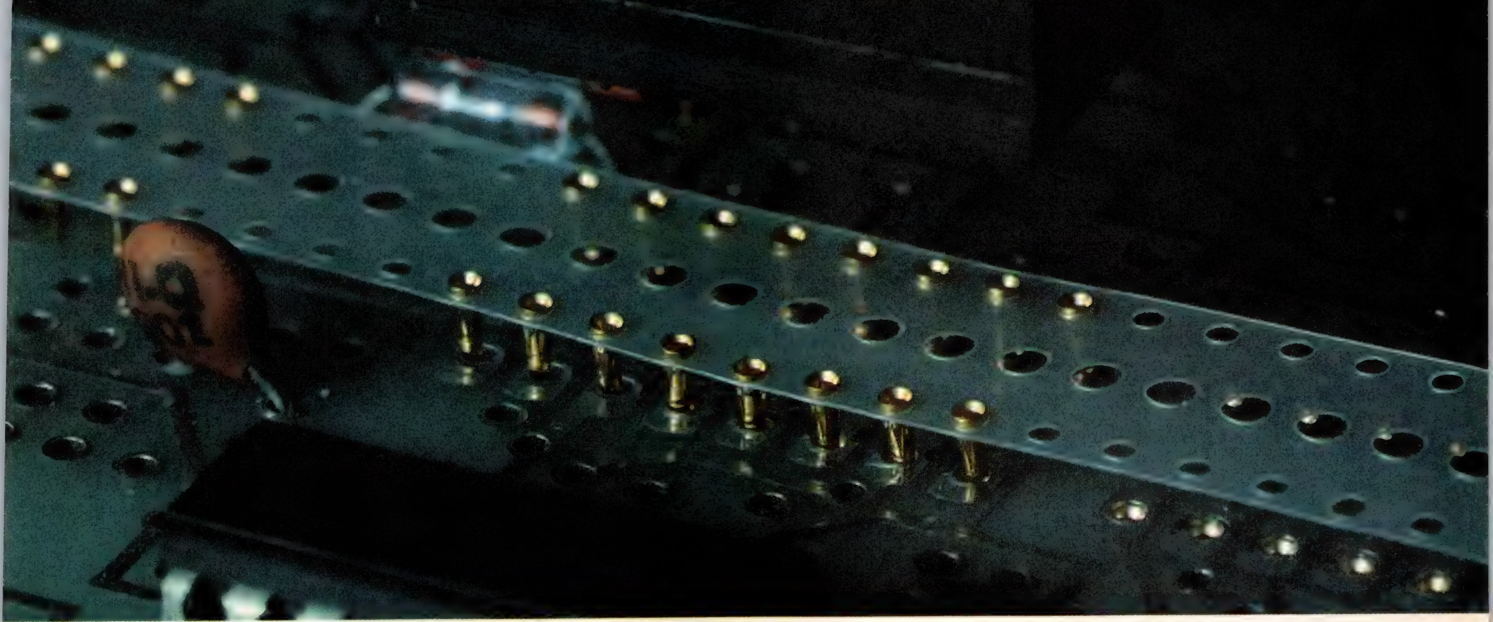

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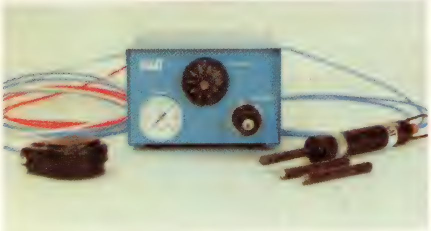

HOLTITE pneumatic hand tool system, Model No. 736-M0020—$495.00.

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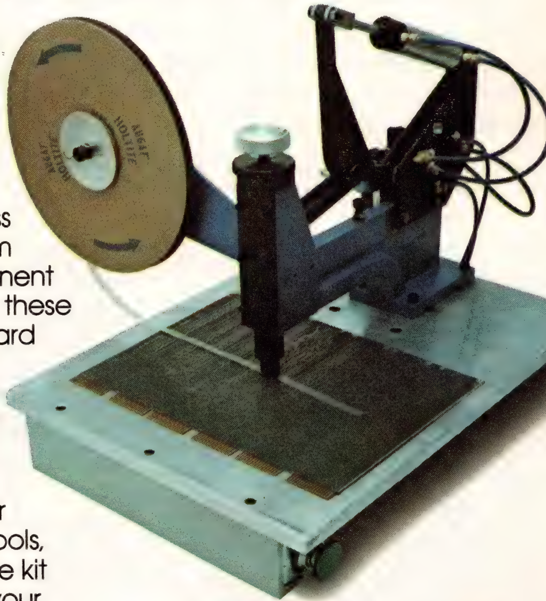
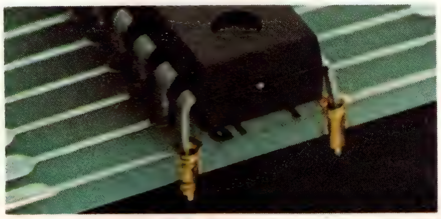


Bench to pneumatic insertion machine, Model No. 736-M0015A—$695.00.



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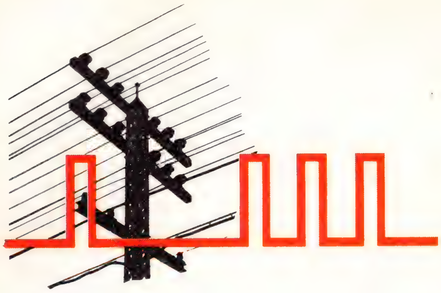


elastic buffer storage within the multiplexer automatically corrects the phase differences between the modem's transmitter and the channel clock. This feature helps reduce errors in communicating with remote terminals.

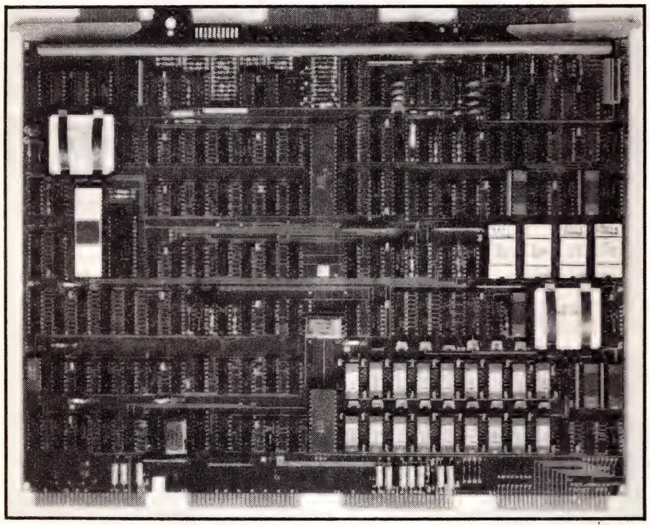
Timeplex's T4,T16 and T20 TDM devices intermix synchronous, asynchronous and isochronous data, formatted in almost any manner from 4, 16 and 20 channels, respectively, with no restriction on channel speed. Then the stream of combined data can be transmitted over such varied data-link types as the DDD network and satellite channels at up to 19.2 kbits/s.

Moreover, for as many as 96 input lines, the T96 handles input-channel speeds up to 256 kbits/s. In addition to incorporating the virtues of the smaller units, the 96-channel device can operate three high-speed data links simultaneously and reroute traffic automatically. An automatic-fallback feature ensures continuing operation in the face of line impairments.

Both frequency-division and time-division multiplexers help transmit data in real time—but a great deal of data need not be transmitted in that context. In that case, systems designers can increase leased-line-use efficiency by balancing the load. That means temporarily storing the data in a buffer for batch transmission during off-hours.

The Comm-Stor family (Sykes Datatronics) of three microcomputer-driven terminal attachments stores data on diskettes from such sources as terminals, printers and modems. Comm-Stor II provides general data-comm port buffering, storage and retransmission capabilities. Comm-Stor III can turn a terminal into a sophisticated form-data entry station with the capacity for unattended data communications. Comm-Stor IV adds programmability, in Basic, to data-entry, storage and retransmission capabilities.

All three models feature single or dual-disk drives with a 256-k character-per-diskette capacity. This translates into 100 to 200 pages per diskette.



A small computer in its own right, HP's intelligent network processor relieves CPUs in the HP3000 series of minis of 90% of the communications-overhead tasks. A μP on board the INP is supported by 32 kbytes of on-board RAM.

Intelligence helps

But when data must be transmitted in real time, say in on-line or interactive systems, fixed TDM can have a serious drawback: The data-link time slots assigned to inactive devices go unused, dropping line-use efficiency—even during peak hours.

A class of μP-based, intelligent TDM devices called statistical multiplexers, or intelligent concentrators, addresses the problem of variable input-channel activity by allocating the high-speed data-link bandwidth only to active inputs. Because the throughput of statistical multiplexers depends on input-channel statistics, no absolute figure can be quoted. In practice, however, the throughput usually improves by about 45% over fixed TDM.

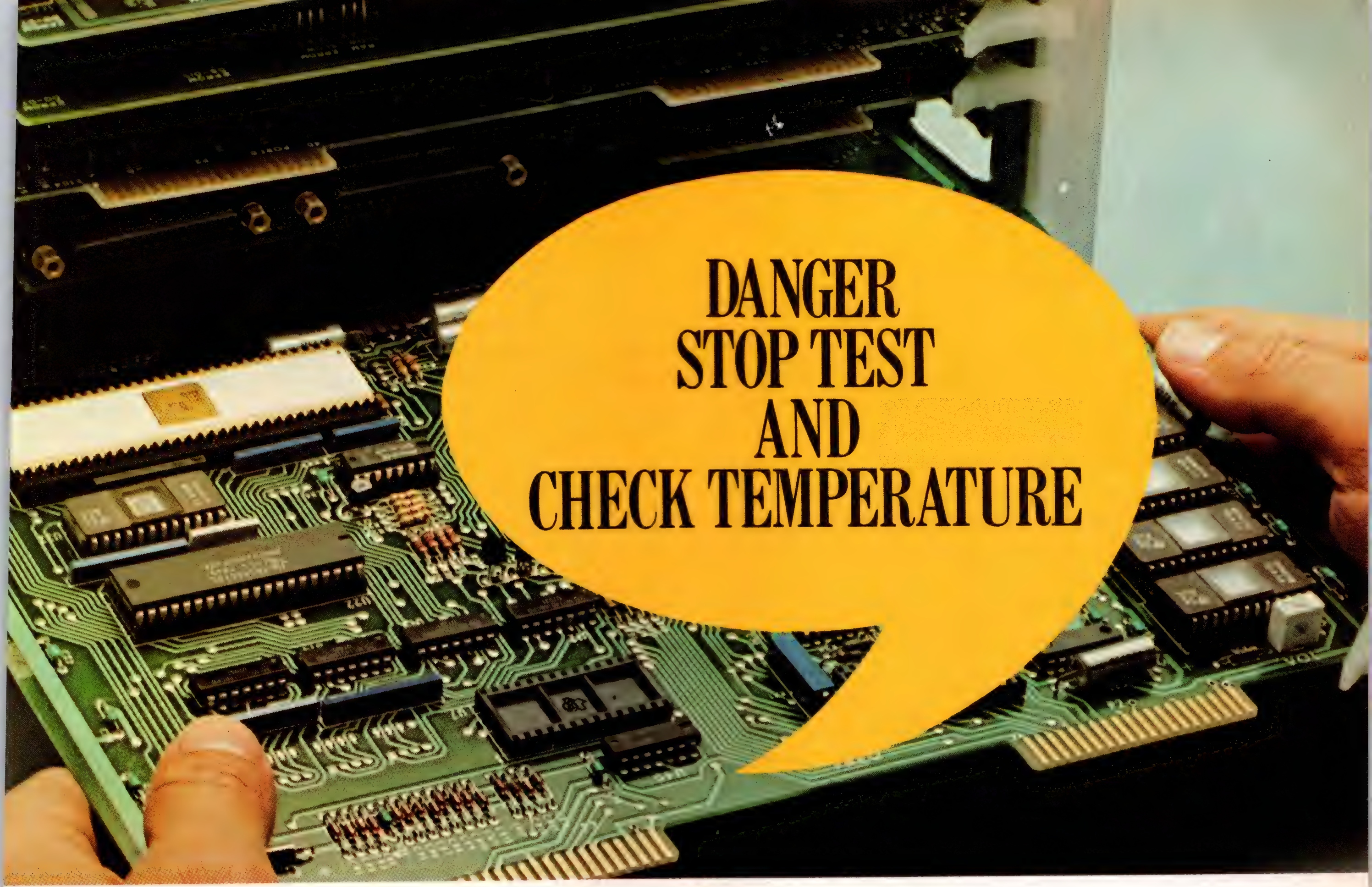
Not only the inputs but also the coding and framing schemes vary for transmitting concentrated data. Individual statistical multiplexers use different data-transmission and then transmit the data in blocks whose lengths vary with the channel's activity.

The Micro 800 is intended to help data-comm-network designers upgrade minicomputer-based systems using "dumb" terminals to performance levels on a par with "smart" terminals working into mainframes. To this end, the Micro 800, as well as the new Micro 900 multidrop concentrator, provides for automatic retransmission-on-error. Both units handle up to 16 remote terminals. The 800 links a cluster of terminals in one regional office to a central mini, over one point-to-point telephone link. The 900 links up to eight regional offices over one multipoint line.

Another statistical network processor that can poll terminals at remote sites along one transmission line is the Prentice SNP-1000. This multiplexer comes in two, four and eight-input-channel models.

Packet switching, under Level 2 of the X.25 international data-communications protocol, controls transmission in Timeplex's Series II microplexers. These devices come in versions that can concentrate four, eight or 24 input channels onto one full-duplex output link operating at up to 19.2 kbits/s or two full-duplex links at up to 9.6 kbits/s each. Each channel can be preassigned one of three priority levels.

Infotron adds data-compression capability to the error protection, two-level priority control and other features of its new intelligent concentrator, the Supermux 680. Input channels can be preselected for com-



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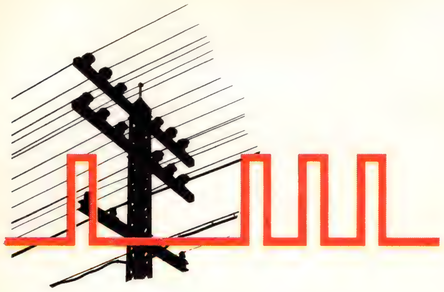

pression, which can be particularly rewarding on channels carrying tabular data. Up to 32 input lines, with an aggregate data rate of 38.4 kbits/s, can be concentrated to pass over one 9.6-kbit/s output line.

At higher levels of networking, remote concentrators like the CC-8R and the bigger CC-80 from Computer Communications concentrate up to 64 and 240 input lines, respectively. They then communicate with the company's CC-80 or CC-85 communications controllers, which can concentrate up to 1232 lines and work with up to seven host CPUs.

Mini or microcomputer-based equipment and systems can have their communications capabilities enhanced with compatible card-level modules. Many of these cards use on-board μPs. Among the most powerful of these front-end communications-controller and expansion boards are those dedicated for operation with such computer systems as the HP3000 series of minis in distributed networks; the SBC single-board family from Intel; the Series/80 BLC/SBC board-level μC system from National; the MDX-CPU1 module, Mostek's Z80-based μC board; the Naked-Mini-4 series of card-level minis from Computer Automation; and the PDP-11 series of minis from DEC.

HP's 300010A and 300020A intelligent network processors link HP3000 computers to other CPUs in a distributed-processing system. Using on-card memory, the INPs assume front-end communications responsibilities, such as control and data buffering for the Bisync protocol used by the system. In half or full-duplex modes, the data rates can go as high as 19.2 kbits/s.

With one of Intel's iSBC 544 boards, four programmable serial-I/O channels, whose communications functions and buffer management are controlled by a dedicated 8085 μP, can be added to equipment containing Intel's single-board computers. Each of the four serial-I/O lines in one of these intelligent communications controllers can be programmed to select the data-comm protocol, synchronous or asynchronous operation, and baud rate. Each channel supports a 26-pin, RS-232C interface. In addition, the board provides a 10-bit, parallel-I/O port that is directly compatible with an automatic calling unit like the Bell 801.

National's BLC-8538 provides eight independently programmable, RS-232C data-comm channels. Each of these full-duplex serial, I/O channels can be programmed for synchronous or asynchronous operation, individual data formats and parity, one-of-16 baud rates up to 19.2 kbits/s, and modem control.

Mostek's MDX-SIO serial-I/O module provides two independent, full-duplex-serial-I/O channels with programmable baud rates to 19.2 kbits/s. The serial-I/O data are sent to the card-edge connector in either 20-mA current-loop or RS-232C form.

Computer Automation's μP-controlled asynchronous-multiplexer card set adds four full-duplex or eight half-duplex, asynchronous, serial-I/O data-comm channels to any computer in the company's Naked-Mini-4 series. Each channel can communicate with a remote or local RS-232C device, at a data rate independently programmable to 19.2 kbits/s.

Able Computer's DV/16 programmable DMA communications multiplexer can speed-up the data-transfer rate of a DEC PDP-11 minicomputer system by transferring words instead of bytes. The four-module unit provides up to 32 channels of synchronous or asynchronous DMA data-transfer capability along with the data-set control for communicating to remote terminals.■■

Data-comm manufacturers

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Cermetek Microelectronics, 1308 Borregas Ave., Sunnyvale, CA 94086. (408) 734-8150.
Computer Automation, 2181 Dupont Dr., Irvine, CA 92713. (714) 833-8830.
Computer Communications, 2610 Columbia St., Torrance, CA 90503. (213) 320-9101.
Digilog Systems, Babylon Rd., Horsham, PA 19044. (215) 672-0800.
Gandalf Data, 1019 S. Noel, Wheeling, IL 60090. (312) 541-6060.
Galite, 2 Tower Dr., P.O. Box 50, Wallingford, CT 06492. (203) 265-7126.
Halcyon, 2 Halcyon Plaza, 2121 Zanker Rd., San Jose, CA 95131. (408) 293-9970.
Hewlett-Packard, 19447 Pruneridge Ave., Cupertino, CA 95014. (408) 725-8111. (Network processors)
Hewlett-Packard, 640 Page Mill Rd., Palo Alto, CA 94304. (415) 493-1212. (Fiber optics)
Honeywell, Honeywell Plaza, Minneapolis, MN 55408. (612) 870-2520.
Infotron Systems, Cherry Hill Industrial Center, Cherry Hill, NJ 08003. (800) 257-8352.
Intel, 2625 Walsh Ave., Santa Clara, CA 95051. (408) 987-8373.
Intertel, 6 Vine Brook Park, Burlington, MA 01803. (617) 273-0950.
Kapusi Laboratories, 2121 S. El Camino Real, San Mateo, CA 94403. (415) 573-5475.
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3M, P.O. Box 33600, Saint Paul, MN 55133. (612) 733-9214.
Mostek, 1215 W. Crosby Rd., Carrollton, TX 75006. (214) 323-6168.
National Semiconductor, 2900 Semiconductor Dr., Santa Clara, CA 95051. (408) 737-6582.
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RCA, New Holland Ave., Lancaster, PA 17604. (717) 397-7661.
Rockwell International, 3310 Miraloma Ave., Anaheim, CA 92803. (714) 632-1086.
Spectronics, 830 E. Arapaho Rd., Richardson, TX 75080. (214) 234-4271.
Sykes Datatronics, 375 Orchard St., Rochester, NY 14606. (716) 458-8000.
Texas Instruments, P.O. Box 225012, Dallas, TX 75265. (214) 238-4422.
Timeplex, 100 Commerce Way, Hackensack, NJ 07601. (201) 646-1155.
Tran Telecommunications, 2500 Walnut Ave., Marina Del Rey, CA 90291. (213) 822-3202.
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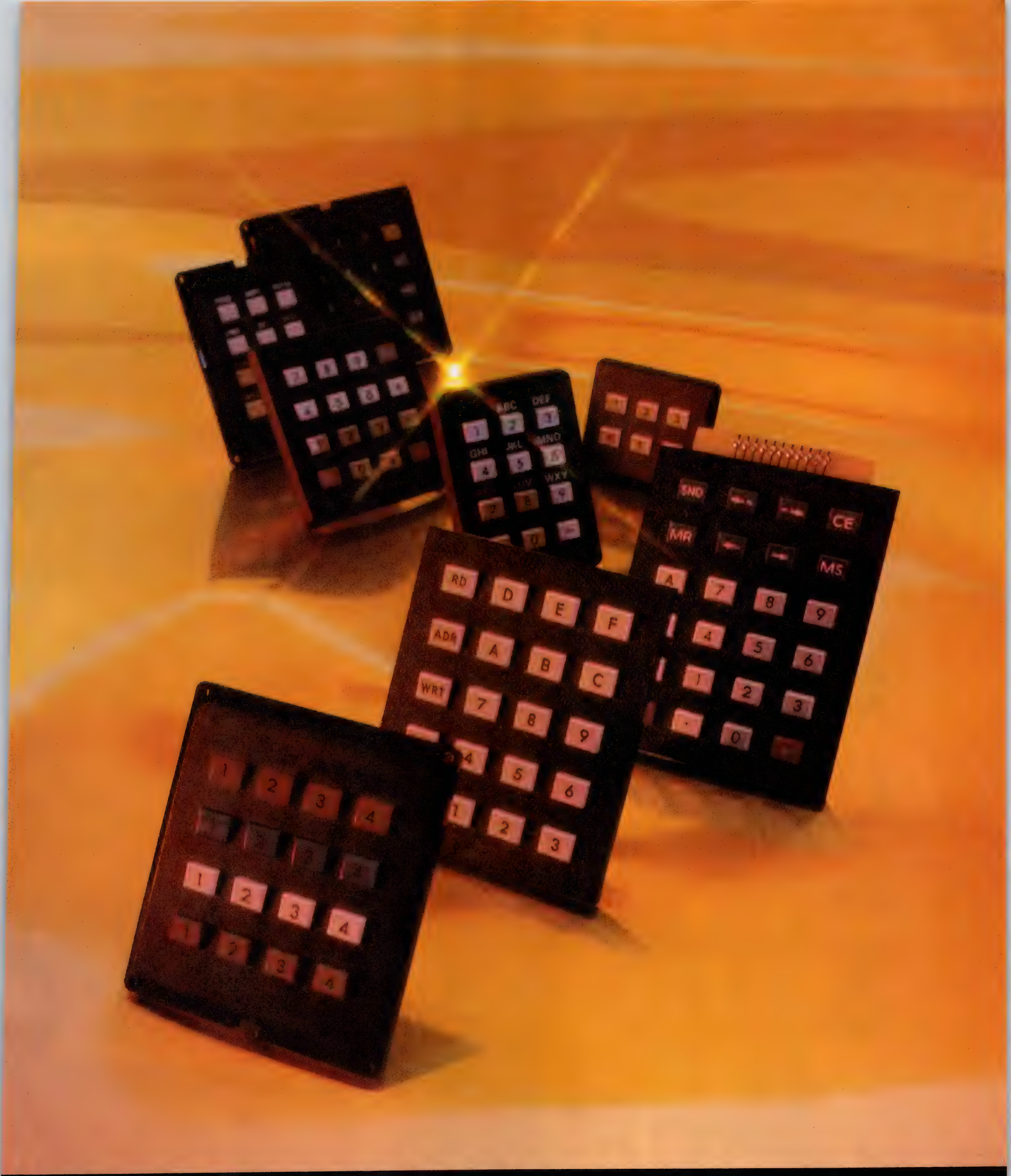
Ven-Tel, 2360 Walsh Ave., Santa Clara, CA 95050. (408) 984-2727.
Versitron, 6310 Chillum Pl., NW, Washington, DC 20011. (202) 882-8464.



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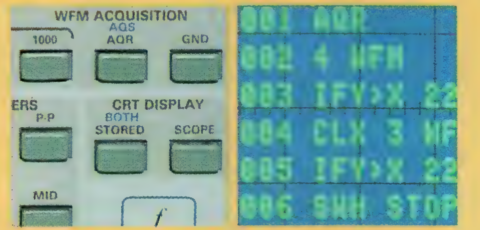
Within seconds, you can obtain repeatable answers like rise time without having to adjust position controls or determine the number of divisions between points.



Keystroke programming.

Like a handheld programmable calculator, the 7854 offers keystroke functions for storing, organizing, and reducing data. You can program the scope to acquire and monitor data without an operator's presence. You can even tailormake special functions to avoid manually repeating a series of keystrokes.

GPIB.

The 7854's GPIB interface provides access to processing in external controllers like the Tek 4050 Series. GPIB also allows mass storage and coordination with other instruments.

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The 7854 is the newest member of Tektronix' well-respected 7000-Series family of high performance scopes. Featuring a real time bandwidth of 400 MHz, it's compatible with 7000-Series plug-in units including differential amplifiers, samplers, DVM's, counter/timers, logic and spectrum analyzers, TDR's, and others.

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The 7854 Oscilloscope brochure and accompanying specifications folder provide full details on this new instrument.

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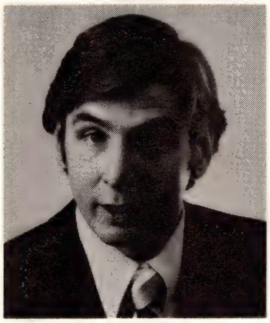

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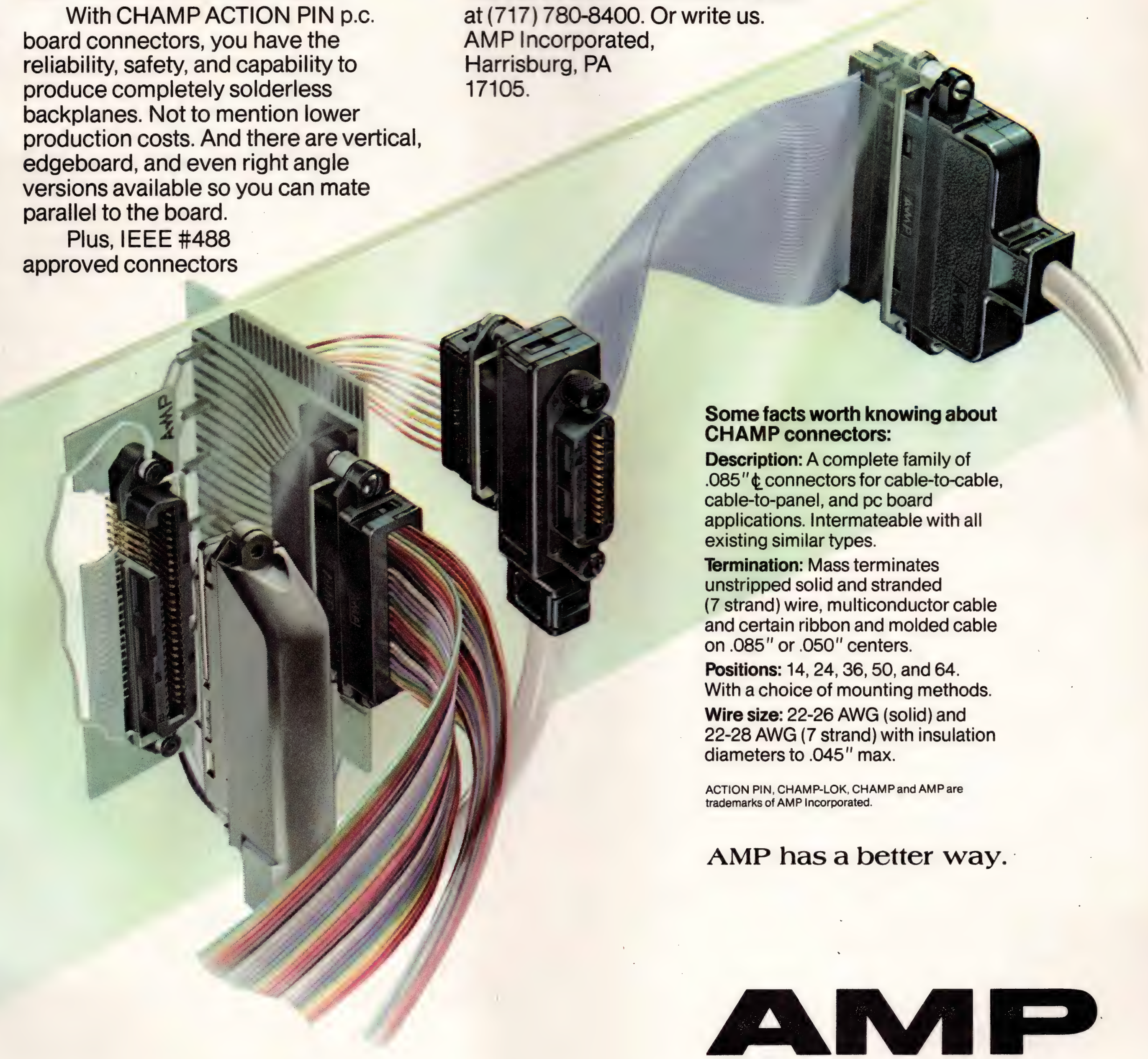

Some facts worth knowing about CHAMP connectors:

Description: A complete family of .085"℄ connectors for cable-to-cable, cable-to-panel, and pc board applications. Intermateable with all existing similar types.

Termination: Mass terminates unstripped solid and stranded (7 strand) wire, multiconductor cable and certain ribbon and molded cable on .085" or .050" centers.

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CIRCLE NUMBER 40

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CIRCLE NUMBER 41

Advanced-NMOS codec-filter chip combines top performance with very low power

Advanced circuitry allows a new NMOS codec-filter chip to meet Bell System D3 and CCITT specifications while drawing just 10% of the power of previous NMOS filter chips—and, remarkably, without any cost or performance tradeoffs. In fact, besides cutting required power dramatically, the MK5912, which contains both transmitting and receiving filters, offers not only the convenience of operation from low-voltage power supplies but also better rejection of low-frequency noise and lower levels of idle-channel noise. To these attributes add small chip size, simple processing and inherently precise response without trimming.

The key to high performance at low power levels lies in advanced designs for both the analog and digital circuitry on the chip. As Fig. 1 shows, the chip has two separate filter sections: one for transmitting, one for receiving. Fig. 2 shows the transmit-channel filter. At the transmit-section input there is an anti-aliasing filter with a nominal 3-dB frequency of 32 kHz. Next comes a third-order monotonic high-pass filter unit that suppresses 50 to 60-Hz signals (and even lower frequencies) that are often induced onto telephone lines from power lines. The high-pass unit uses a doubly terminated switched-capacitor ladder sampled at 256 kHz.

Putting the anti-aliasing and high-pass units first protects the dynamic range of the next section, a low-pass, fifth-order elliptic filter. The overall transmit section has a response within the Bell System D3 specifications (striped areas in Fig. 3a).

The receive section also contains a fifth-order, elliptic, low-pass, doubly-terminated, switched-capacitor ladder. Pole and zero locations provide the required sin x/x peaking of the low-pass response to match the codec. With the appropriate codec, the overall receive-channel response is also within the Bell System D3 specifications, as Fig. 3b shows.

In addition, the receive-channel output can directly drive a two-wire to four-wire telephone-line hybrid,

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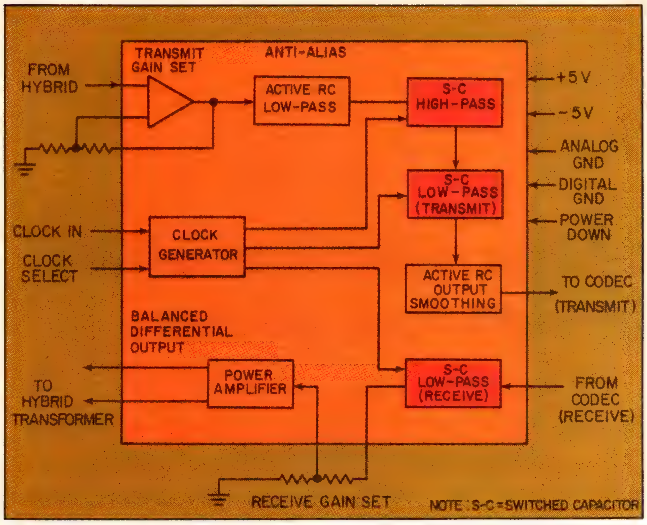
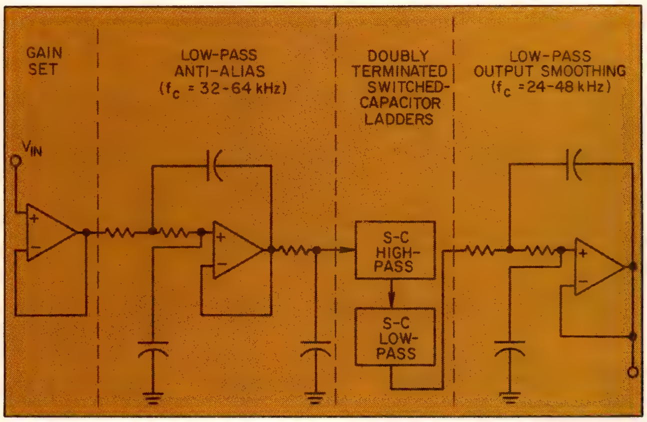
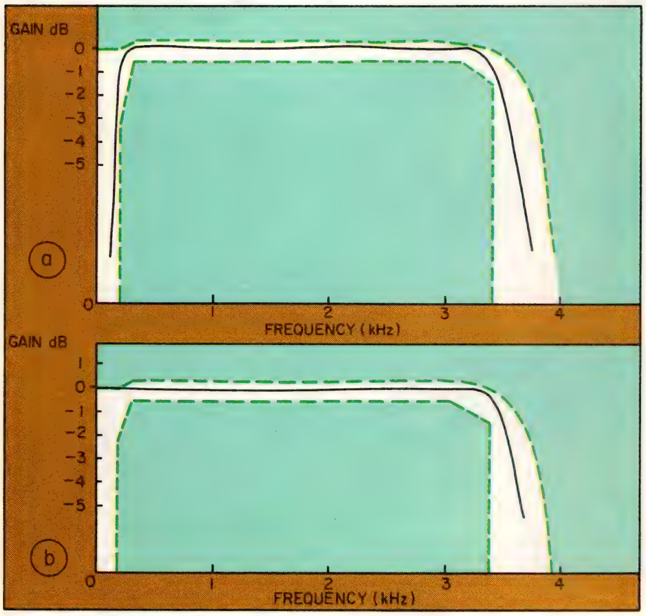
Ian A. Young, Section Leader, Telecommunications Design, **David B. Hildebrand,** Telecommunications Design Engineer, and **Charles B. Johnson,** Telecommunications Design Manager, Mostek, Carrollton, TX 75006.



1. **Advances in both the analog and digital circuitry of the MK5912 PCM codec filter chip cut power while boosting performance. The analog transmit and receive sections are completely independent.**


GAIN SET
LOW-PASS ANTI-ALIAS (f_c = 32-64 kHz)
DOUBLY TERMINATED SWITCHED-CAPACITOR LADDERS
LOW-PASS OUTPUT SMOOTHING (f_c = 24-48 kHz)
V_{IN}
+
−
S-C HIGH-PASS
S-C LOW-PASS

2. **For transmit-channel filtering, anti-aliasing and high-pass sections come before the low-pass, fifth-order elliptic section to protect dynamic range.**



3. **The transmit and receive-filter responses lie within the Bell D3 and CCITT specifications. The transmit response (a) is for the filter alone, while the receive response (b) includes the codec's sin x/x low-pass.**

by means of an on-chip differential power amp. This receive-channel power amp can send as much as 10 dBm into a matched 300-Ω transformer winding.

Earlier monolithic versions of PCM filters realize the dual elements of the transmit filters with switched-capacitor techniques. But these usually suffer from two major drawbacks:

- Sensitivity to parasitic capacitances
- Dependence on ratioed resistive elements to set absolute gain values and locate the zeroes. Resistive, rather than capacitive, loads cause the op amps to consume more precious power.

The new chip also uses switched-capacitor techniques to create the long virtual time constants needed in low-frequency active filters. But here, too, lies a crucial difference. The MK5912's filtering transfer function has been made insensitive to parasitic capacitance. Also, the critical frequencies and absolute gain through both the transmit and receive filters are controlled only by MOS-capacitor ratios. As Fig. 4 shows, the usual R-C combinations are not used in the fifth-order, elliptic low-pass section.

Of course, active filters that use switched capacitors in place of power-consuming R-C elements still need op amps. But, because of the parasitic-insensitive switched-capacitor operation, these circuits drive only small capacitive loads. Hence, more power saving accrues because the new scheme uses op amps with low operating currents in its active filters.

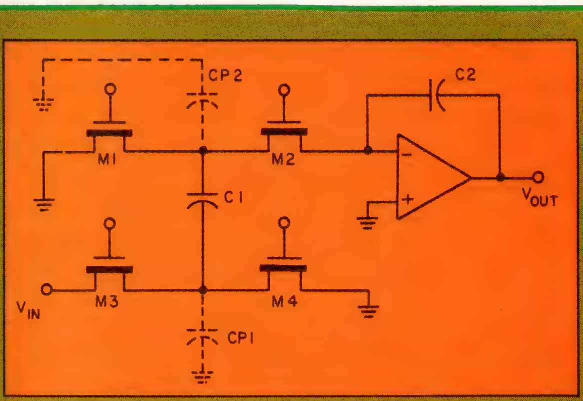
The chip's interface amplifiers also save power. At the peripheral analog interface, another op amp—this one with an efficient push-pull output stage—drives moderate-level impedances (down to 3 kΩ) at the expense of only minimal current with no load.

Yet another power-saving amplifier, whose drive capability boosts NMOS to new limits, uses an effi-

Table 1. Typical filter performance (at ±5 V and 25 C)

	Transmit filter	Receive filter (with sin x/x filter)
Total power consumption:		
in standby mode	200 μW	
with power amplifier inactive	20 mW	
with power amplifier driving −20 dBm into 600 Ω	25 mW	
with power amplifier driving 0 dBm into 600 Ω	70 mW	
Passband ripple (300-3200 Hz)	±0.05 dB	±0.08 dB
Stop-band rejection (>4600 Hz)	−34 dB	−42 dB
Delay distortion (1000-2600 Hz)	35 μs	120 μs
60-Hz rejection	30 dB	—
50-Hz rejection	35 dB	—
16-Hz rejection	60 dB	—
Nominal 0-dBm0 level at output	2.26 V peak	2.26 V peak
Total harmonic distortion at +3 dBm0, 1 kHz	−50 dB	−45 dB
Idle channel noise, filter only	6 dBrnC0	6 dBrnC0
Idle channel noise: transmit filter/codec/receive filter, end to end	12 dBrnC0	
1-kHz absolute gain variation	±0.1 dB	±0.1 dB
Supply-voltage coefficient of absolute 1-kHz gain	0.04 dB/V	0.04 dB/V
Power-supply rejection of V_{CC} at 1 kHz	39 dB	40 dB
Power-supply rejection of V_{BB} at 1 kHz	28 dB	36 dB

Cutting the effects of stray capacitance



Switched-capacitor ladder filters can realize high-order precision frequency responses because they stimulate low-sensitivity, passive, LC-ladder inductor currents and capacitor voltages. The switched-capacitor integrator's phase shift must be precisely 90° to ensure low sensitivity of the L-C ladder. For other than 90° phase shifts, the LC elements appear to be lossy. As a result, the ladder-filter response will be degraded and more sensitive to component variations.

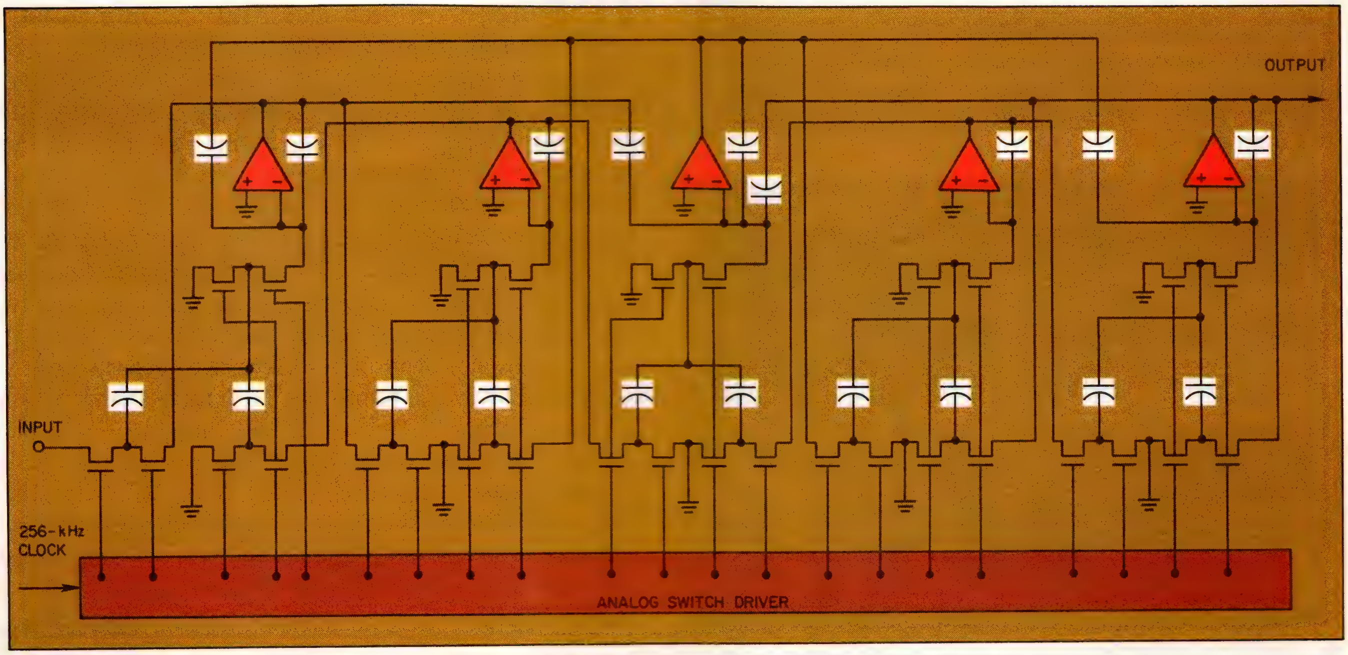
Proper timing of the switched-capacitor integrators in the ladder filter can simulate ideal lossless elements. Examine the figure depicting the basic switched-capacitor integrator used in the ladder filter. If transistors M_1 and M_3 are both ON in the first half-period of the clock that controls the switched-capacitor, and M_2 and M_4 are both ON in the second half-period, then this integrator will be noninverting and have some effective phase lag in addition to the 90° of an ideal integrator. This results because there is some delay between when the input is sampled and when it is integrated.

On the other hand, if transistors M_2 and M_3 are ON at the same half-period and M_1 and M_4 are ON at the other half-period, this circuit is an inverting integrator. In this case, there is no delay between when the input is sampled and when the sample is integrated since there is a direct signal path from the input to the output of the integrator. Under these timing conditions, the integrator has slightly less than 90° of phase lag.

In a switched-capacitor ladder filter, these two types of integrators are connected to form loops of two integrators. These loops are coupled by leapfrogging out of one loop back into another. Since each loop in the ladder filter operates with one noninverting integrator and one inverting integrator, the phase shift around the two integrators is the same as one gets from using ideal integrators with exactly 90° phase lag. Thus, the integrator loop behaves ideally and the LC elements being simulated are effectively lossless and have low sensitivity.

There is one other very important advantage to using the two switched-capacitor integrators described. Since the capacitor node (C_{P2}) between M_1 and M_2 is switched between the real ground and virtual ground of the amplifier, parasitic capacitance connected to this node doesn't affect the integration of the input signal. What's more, the node (C_{P1}) on the other side of the capacitor, between M_3 and M_4, is switched between the input (voltage source) and ground. Thus, the parasitic capacitance at this node is charged by the input and then discharged to ground during each clock period. Hence, it doesn't interfere with the integrator.

As a result, the input switched capacitor is insensitive to parasitic capacitance, and is not required to be large in comparison to the parasitic capacitances on its top and bottom plates. What's more, the silicon area needed to implement the MOS capacitors in the switched-capacitor ladder filter is greatly reduced.



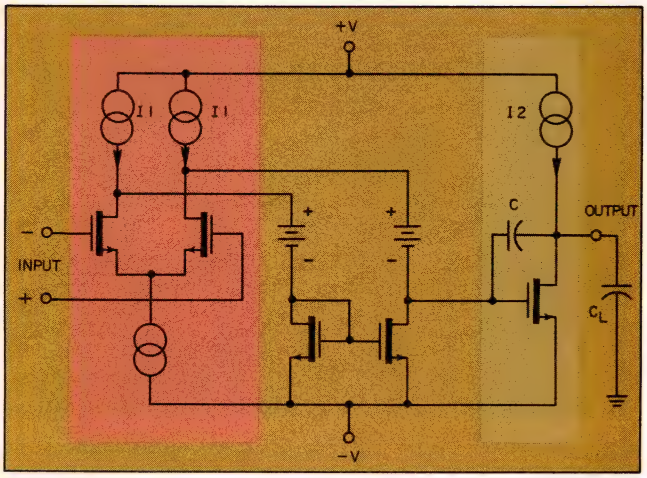
4. The fifth-order, elliptic, low-pass section used in both the transmit and receive sections does not use the usual inductance and capacitance combinations. Instead, doubly-terminated switched-capacitor ladder circuits simulate lossless L and C components.

cient Class-AB power-output stage to drive the required 600-Ω telephone-line impedance. This MOS driver rivals bipolars for output-drive capability, while maintaining the high efficiency characteristic of MOS output stages. The stage uses a slight dc bias that ensures freedom from crossover distortion.

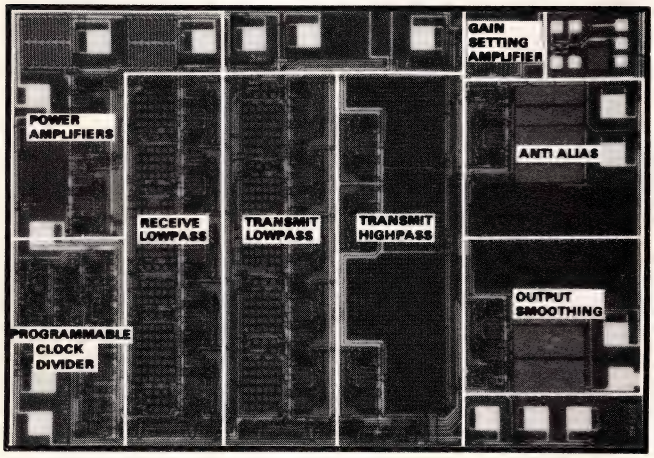
The upshot of all this is that even though the chip contains 18 op amps, it typically consumes just 20 mW when active. The op amps take less than 1 mW each.

Table 2. System specs for PCM filters

Passband flatness:	central office (2-wire)	+0.25 dB, −0.5 dB, 300 to 3000 Hz
	Toll office: (wire)	+0.15 dB, −0.15 dB, 300 to 3000 Hz
Stop-band rejection:	transmit channel	−32 dB above 4600 Hz
	receive channel	−28 dB above 4600 Hz
Dynamic range		>85 dB
Transmit 50/60-Hz rejection		>20 dB
Absolute gain variation		±0.1 dB



5. **NMOS operational amplifiers for the MK5912's active filters (shown simplified) save power because they drive light, capacitive-only loads. This keeps operating currents to a minimum.**



6. **Just 77 × 108 mil² of silicon suffices for the complete chip. Innovative circuitry has cut passive-component requirements to 350-pF MOS capacitance and 600-kΩ polysilicon resistance.**

The chip also has a powered-down or standby mode in which the IC draws even less power—typically 200 μW. In many applications, this standby feature can mean substantial savings, especially in equipment with many separate lines where statistics favor an activity ratio of less than unity. Then the power-supply and cooling requirements can be lessened.

However, driving high power levels into standard subscriber lines increases power consumption. With the power amp driving −20 dBm into 600 Ω, the chip draws 25 mW. With 0 dBm being driven into 600 Ω, the chip draws 70 mW.

For more on these and other significant features of the transmit and receive sections of the filter IC when it operates with ±5-V supplies at 25 C, see Table 1. Table 2 lists the pertinent system specifications for PCM filters. Comparison of the performance and specification values shows that the new filter chip is well within the required range.

Another aspect that has received attention in the design of this chip is the digital control for the filter. Power drawn by the programmable clock divider and switch drivers, which in older NMOS filters draw more power than the entire new chip, has also been reduced to levels previously associated only with CMOS. In the digital circuits, the power problem could have been magnified because the chip uses both random logic and a high-speed programmable clock-divider. However, two-phase ratioless dynamic logic eliminates the static dc plaguing designers of NMOS depletion-load logic.

What's more, instead of the usual 128-kHz clock frequency, the MK5912 uses 256 kHz. The higher sampling frequency, in effect, means less high-frequency noise is aliased down into the voice bandwidth than with the lower sampling frequencies. In addition, noise sources at the input and intermediate stages of the op amps have been identified and minimized.

Like noise, the size reduction depends on interrelated factors. First, the parasitic-insensitive circuitry permits using low absolute capacitance values, even though very high ratios are needed. For example, the high-pass element in the transmit section operates successfully with only a 0.1-pF switched input capacitor for its integrators. Low capacitance values, of course, translate into less silicon area. The lower absolute capacitance values, in turn, require lower-power op amps, which also take up less room. The Class-AB output amplifiers are also reduced.

All the filter functions have been implemented with a total of only 350 pF of MOS capacitance and 600 kΩ of polysilicon resistance. The result of all this silicon saving is a rather small die of 77 x 108 mil² (Fig. 6). Because IC yields often depend heavily on die size, the new chip should be easy to produce.■■

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Immediate design application	**541**
Within the next year	**542**
Not applicable	**543**

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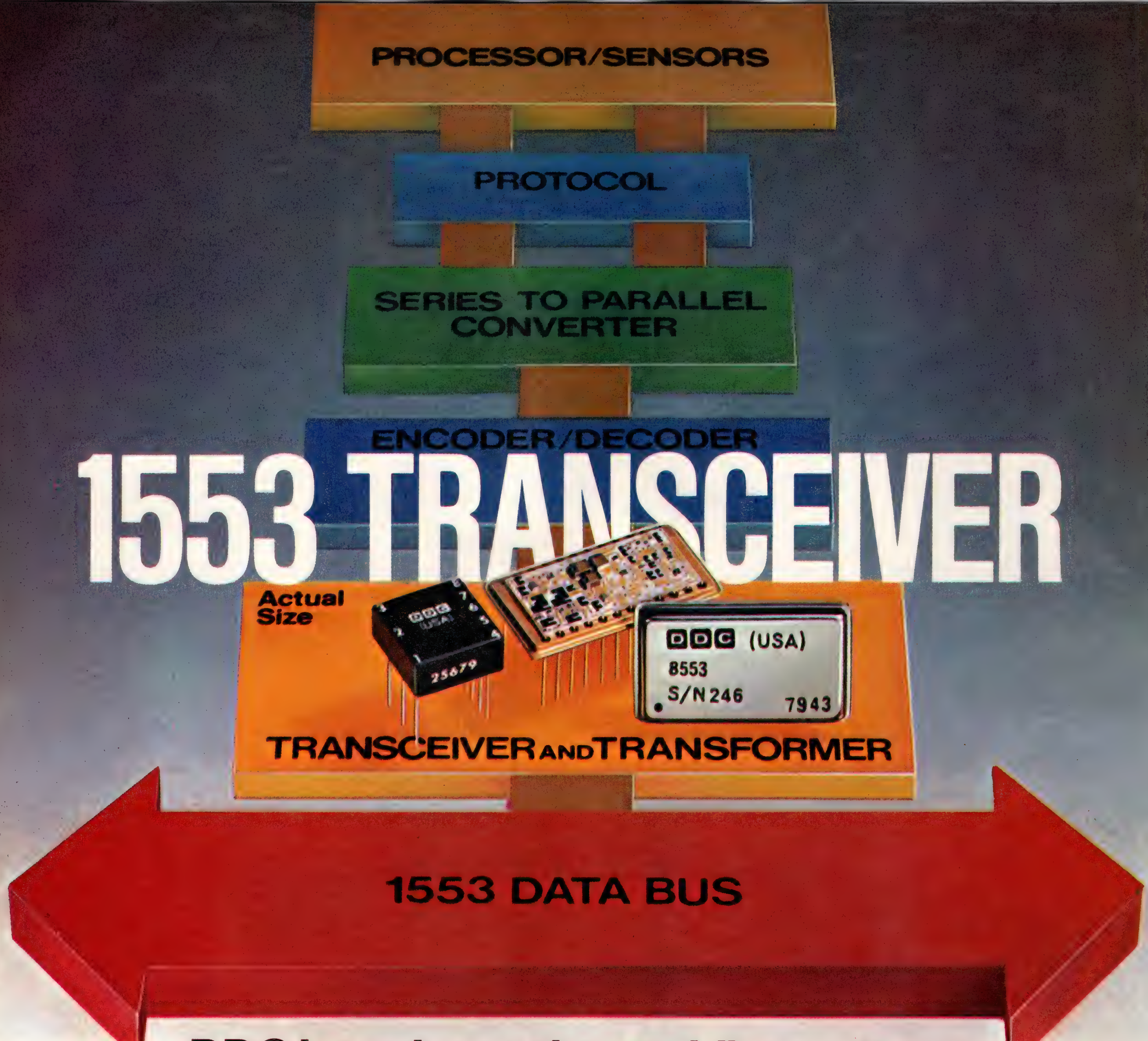
CIRCLE 42 FOR DATA.



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CIRCLE NUMBER 43

Programmable data-comm chip unloads CPUs by running synchronous line protocols

Many of the design problems plaguing controllers for multiple, synchronous telecommunications protocols can be solved by a new data-link-control (DLC) chip. By efficiently performing much of the required protocol processing, Fairchild's F6856 removes virtually all of the line-control-overhead burden from its associated processor. Capable of supporting both bit and character-oriented protocols (BOPs and COPs), the programmable LSI circuit simplifies the interface design of universally compatible data-comm equipment.

With line-control protocols proliferating and more of them promising to emerge, universality is unquestionably a standout feature for data-comm equipment. Putting the line protocol under program control while keeping down CPU overhead could greatly extend the life of a data-comm-equipment design.

Simple on-line reprogramming switches the DLC protocol among the most popular versions of BOPs and COPs, including SDLC, HDLC, DDCMP and complete Bisync. In addition, the 6856 performs the bulk of the required link-control processing, including:

- Converting parallel data from the CPU to a continuous serial-data stream for transmission, while simultaneously converting received serial data to parallel data for the CPU
- Changing transmission codes to computer codes (normally NRZI to NRZ) and monitoring in-transit streams of bits and characters for control designators and delimiters such as SYNC, FLAG, ABORT, etc.
- Deleting and inserting bits and characters as required by the protocol
- Interrupting the processor on end-of-message or under abnormal conditions (data overrun or underrun)
- Accumulating cyclic-redundancy-check (CRC) characters for error detection, performing CRC checking, and providing a number of CRC options including CRC-16, CRC-14, CRC-12, CRC-10 and CCITT-CRC
- Facilitating self-diagnosis, upon CPU command, by internally connecting the transmitter output and receiver input.

Fully TTL-compatible and operating from a single 5-V supply, the chip is organized to interface with either an 8 or 16-bit bidirectional data bus. As Fig. 1 shows, it interfaces easily with most microprocessors and mini or microcomputers to control a data-communications line. As Fig. 2 shows, the device is functionally partitioned into the receiver, transmitter and addressable registers, and into data-bus control.

Chip flexibility stems from the programmability provided by four 16-bit addressable registers, which specify the protocol and options within the protocol. Fig. 3 shows the bit assignments for each register,

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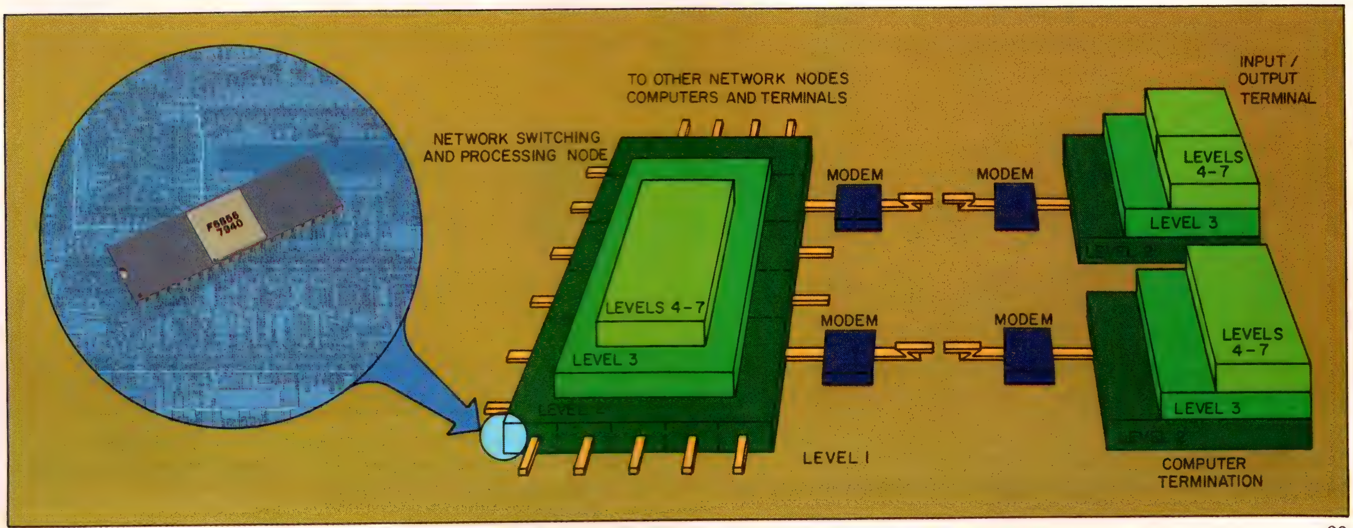
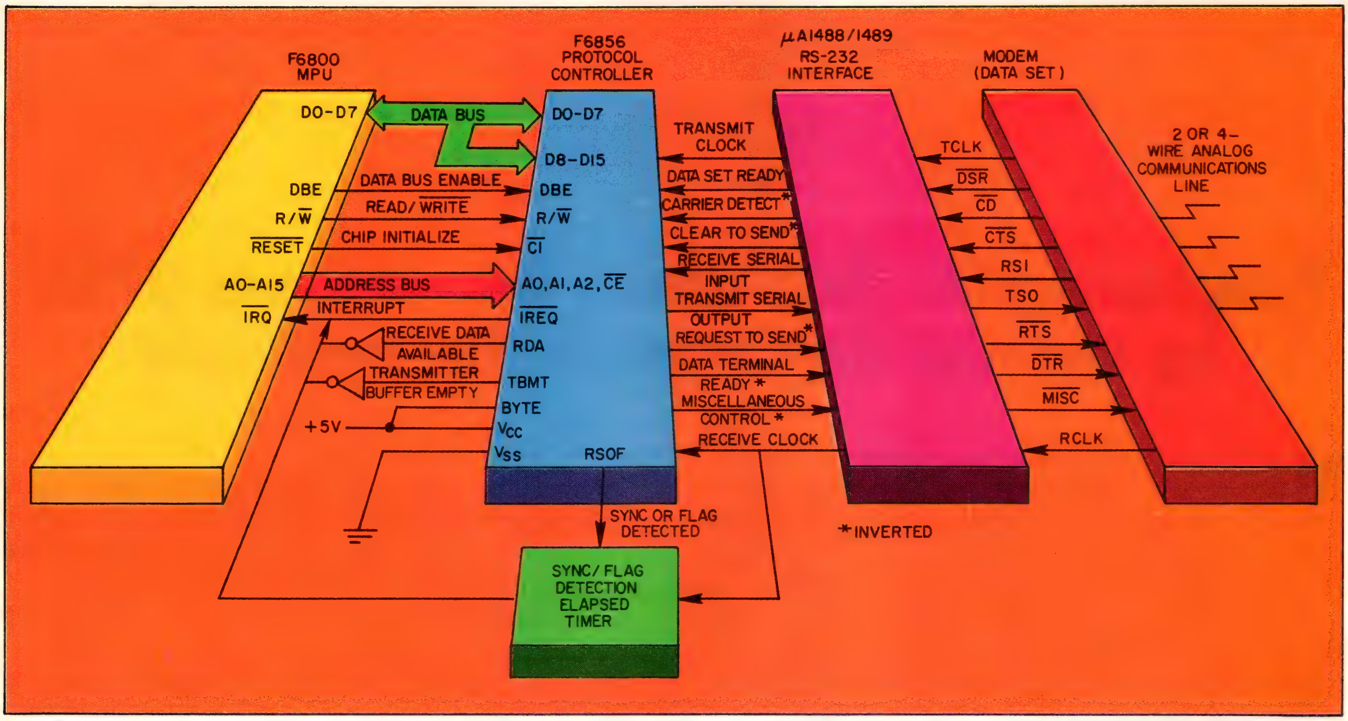
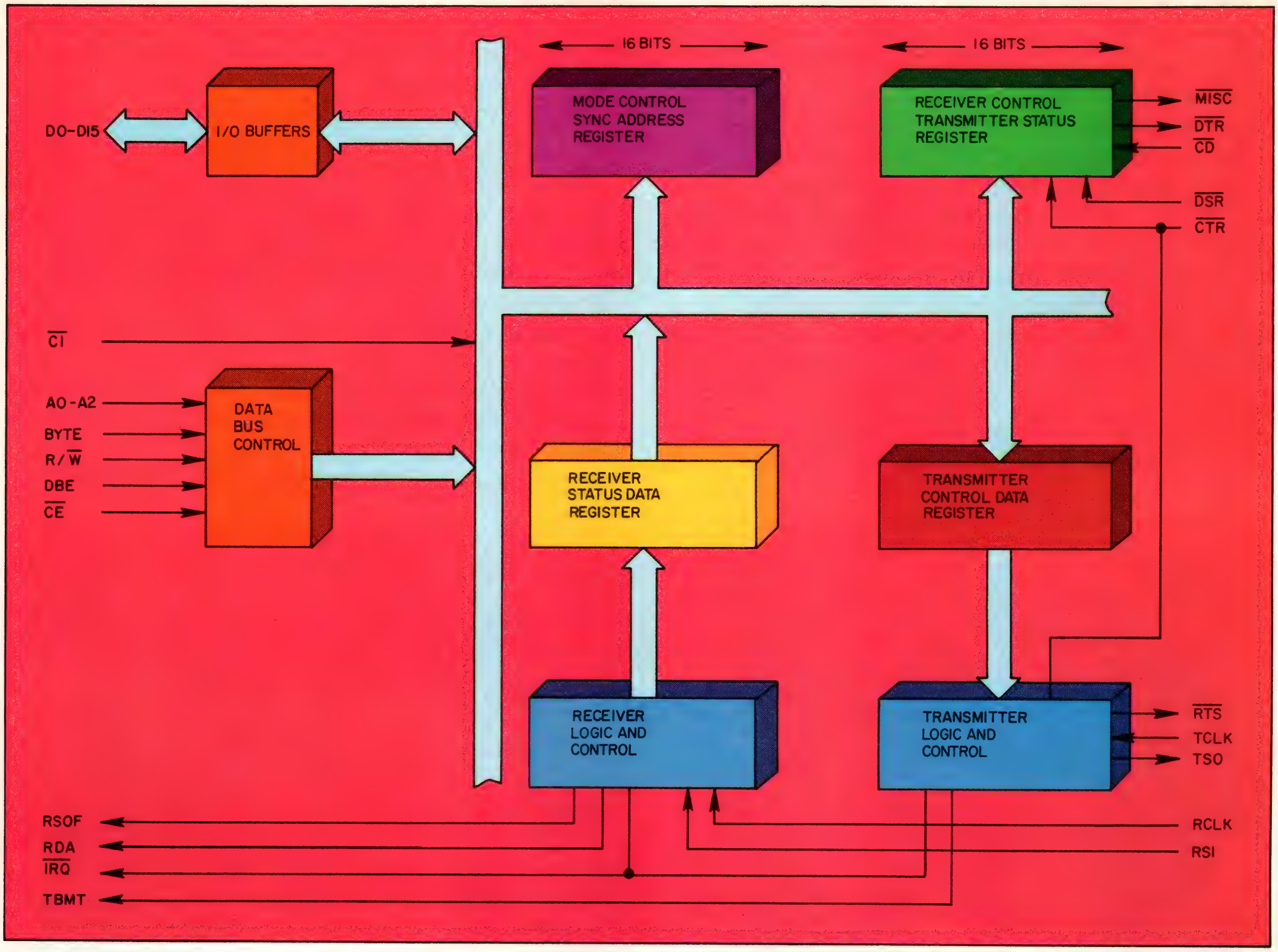
Roy Kole, Manager, Telecommunications Products, **William Nienhaus,** Senior Staff Engineer, Fairchild Camera and Instrument Co., 464 Ellis St., Mountain View, CA 94042.





1. The F6856 programmable protocol-control chip for synchronous data communications interfaces easily with the 8 or 16-bit bidirectional data buses of popular mini and microcomputers.



2. The protocol-control chip is partitioned into receiver, transmitter and addressable registers, with a section reserved for controlling the data bus. Programmable data in the four 16-bit, addressable registers determine the data-communications protocol and appropriate options that will govern chip operation.

F6856 signals and definitions

D_0-D_{15}—Data Bus (I/O)
Contains bidirectional data status and control information to and from the CPU. Lines D_0 through D_7 may be wire-ORed to D_8 through D_{15} for use as an 8-bit data bus.

A_0-A_2—Register Address (I)
Selects internal data. Status and control registers. The internal registers may be selected as eight or 16 bits.

BYTE—Byte (I)
A high level indicates an 8-bit data bus. A low level indicates a 16-bit bus.

$\overline{\text{CE}}$—Chip Enable (I)
A low level enables a data-bus transfer with DBE.

R/$\overline{\text{W}}$—Read/$\overline{\text{Write}}$ (I)
A high level allows data from the addressed register to be output to the data bus. A low level allows data from the bus to be loaded into the addressed register.

DBE—Data Bus Enable (I)
A strobe here transfers information between the data bus and the addressed register when CE is low.

$\overline{\text{CI}}$—Chip Initialize (I)
A low level initializes the internal control registers and timing.

RCLK—Receiver Clock (I)
Provides timing for the receiver logic. RCLK frequency is the same as the received baud rate.

RSI—Received Serial Input (I)
Receives serial data. Data changes on the positive-going edge of RCLK.

TCLK—Transmitter Clock (I)
Provides timing for the transmitter logic. TCLK frequency is the same as the transmitted baud rate.

TSO—Transmitter Serial Output (O)
Transmits serial data. Data changes on the positive-going edge of TCLK.

RDA—Receiver Data Available (O)
A high level indicates an assembled character is in the receiver buffer. RDA is reset on the trailing edge of DBE when the receiver buffer is read by the CPU.

RSOF—Received Sync or Flag (O)
RSOF is high for one receiver clock period each time a received sync or flag is detected.

TBMT—Transmitter Buffer Empty (O)
A high level indicates the device is ready to receive new data and control information from the CPU. TBMT is reset on the trailing edge of DBE when the transmitter buffer is loaded.

$\overline{\text{IRQ}}$—Interrupt Request (O)
A low level indicates either the end of a received message or that an error has occurred as a result of a Receiver Overrun (ROVR) or Transmitter Underrun (TUR). ROVR occurs if the CPU fails to read data from the receiver buffer before it is overwritten by the next assembled character. TUR occurs if the CPU fails to load the transmitter buffer within one character time after TBMT goes high. $\overline{\text{IRQ}}$ is reset on the trailing edge of DBE when the receiver status is read for an ROVR or the transmitter status for a TUR.

$\overline{\text{DTR}}$—Data Terminal Ready (O)
General-purpose in nature, DTR can be set low by programming the appropriate bit of the receiver-control register.

$\overline{\text{DSR}}$—Data Set Ready (I)
General-purpose in nature, DSR can be tested by the CPU by reading the transmitter-status register.

$\overline{\text{CD}}$—Carrier Detect (I)
General-purpose in nature, $\overline{\text{CD}}$ can be tested by reading the transmitter-status register.

$\overline{\text{RTS}}$—Request to Send (O)
Used with $\overline{\text{CTS}}$ to enable the transmitter, RTS may be set low by programming the appropriate bit of the transmitter-control register.

$\overline{\text{MISC}}$—Miscellaneous
General-purpose in nature, MISC can be set low by programming the appropriate bit of the receiver-control register.

$\overline{\text{CTS}}$—Clear to Send (I)
Used with $\overline{\text{RTS}}$ to enable the transmitter, $\overline{\text{CTS}}$ can be tested by reading the transmitter-status register.

whose contents may be altered on-line to change the protocol.

The Mode-Control and Sync/Address register (Fig. 3a) is a directly addressable, write-only register used to configure the chip for a specific data-comm environment. It should be programmed after initialization and before initiating transmission or reception of data.

The register's contents may be changed whenever the receiver or transmitter is disabled. The upper eight bits contain mode-control information common to the receiver and transmitter. The lower eight bits contain the programmed SYNC character in COP or the secondary address in BOP. They are not used in the Bisync mode.

The directly addressable-write-only Transmitter Control and Data register (Fig. 3b) controls the format of the transmitted data. The upper byte contains control information for the transmitter; the lower byte contains the characters to be transmitted. This register may be updated whenever the TBMT output is high.

The Receiver Control and Transmitter Status register (Fig. 3c) is also divided into two bytes. The upper byte is a directly addressable write-only register that contains control information specifically related to the reception of data and the $\overline{\text{DTR}}$ and $\overline{\text{MISC}}$ general-purpose outputs. The lower byte contains transmitter and modem-status information. The bits that control the received character length should not be changed while the receiver is enabled.

The fourth register is the Receiver Status and Data register (Fig. 3d). It contains receiver-status information and the assembled received character.

Problems? What problems?

Armed with all this capability and flexibility, the F6856 solves many data-link control problems, including:

- The Bisync problem
- The compatibility problem
- The resource-allocation problem
- The protocol-control problem
- The testing problem.

Much existing equipment operates under Bisync, a complex protocol with many modes (contention, multidrop, dial) and numerous data formats. Hence, implementing Bisync requires extensive programming —generally on the order of 4 kbytes and often more, depending on the system.

Unfortunately, the installed base of Bisync-based equipment is usually too large to be ignored in new designs. At the same time, however, providing compatibility with Bisync-based equipment often can double the cost of designing a new terminal or con-

Seven levels of rules

Sets of rules—protocols—make modern data communications possible. Hierarchies make protocol control possible by clearly defining the interfaces between each protocol level. Perhaps the most popular architecture is the seven-level protocol hierarchy defined by the International Standards Organization (ISO).

Under this hierarchy, any telecomm device that adheres to the disciplines of the protocol can exchange information with any other equipment under the same disciplines—regardless of application, type or equipment manufacturer. Also, any network that provides compatible protocols at levels 1, 2 or 3 can be accessed for information transfer regardless of its protocols for levels 4 through 7. Consequently, compatibility is ensured through a network and among termination equipment.

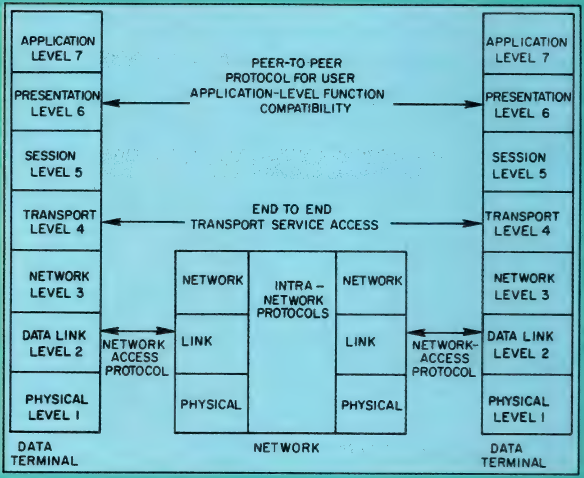
The first four levels of the ISO scheme concern equipment designers the most. Level 1 is the most basic. It sets forth the fundamental mechanical, electrical and functional controls, and defines voltage levels and the number of connector pins. Level 1 also specifies the signals and signal-control sequences on the physical links between data-terminal equipment and circuit-terminating equipment, or between data terminals.

Level 2 sets the rules for data-link control, defining data formats, error-control procedures and link-control activities. Level 3 sets the rules for network control, incorporating network-related controls that define block structure, accessing and sequencing procedures.

Level 4 sets up the transport controls that ensure that data flows independently of the network and that the connection is reliable. Also, level 4 defines the rules for verifying data.

Levels 5 through 7 are usually the concern of systems designers rather than device makers. Level 5 provides a set of rules that controls session procedures and requirements, and allocates resources. Level 6 controls presentations, providing the conversion format of coded information blocks to I/O, transmission and storage devices. And, finally, level 7 provides application controls. This level is necessarily application specific.

Level-2 protocols are particularly important to both data-comm equipment and system designers because



they assure orderly exchange of information across a data link. For this reason, level-2 compatibility is a key to designing general-purpose equipment that can be programmed for a wide variety of uses. In addition, such compatibility opens the door to the higher-level protocols. Level-2 protocols supervise the following functions:

Initialization, or start-up control, begins the process to start transmissions in an idle system.

Framing locates transmission-block beginnings and endings via message-delimiting bit groups.

Link management not only controls transmissions and receiving but also supervises data-transfer sequences.

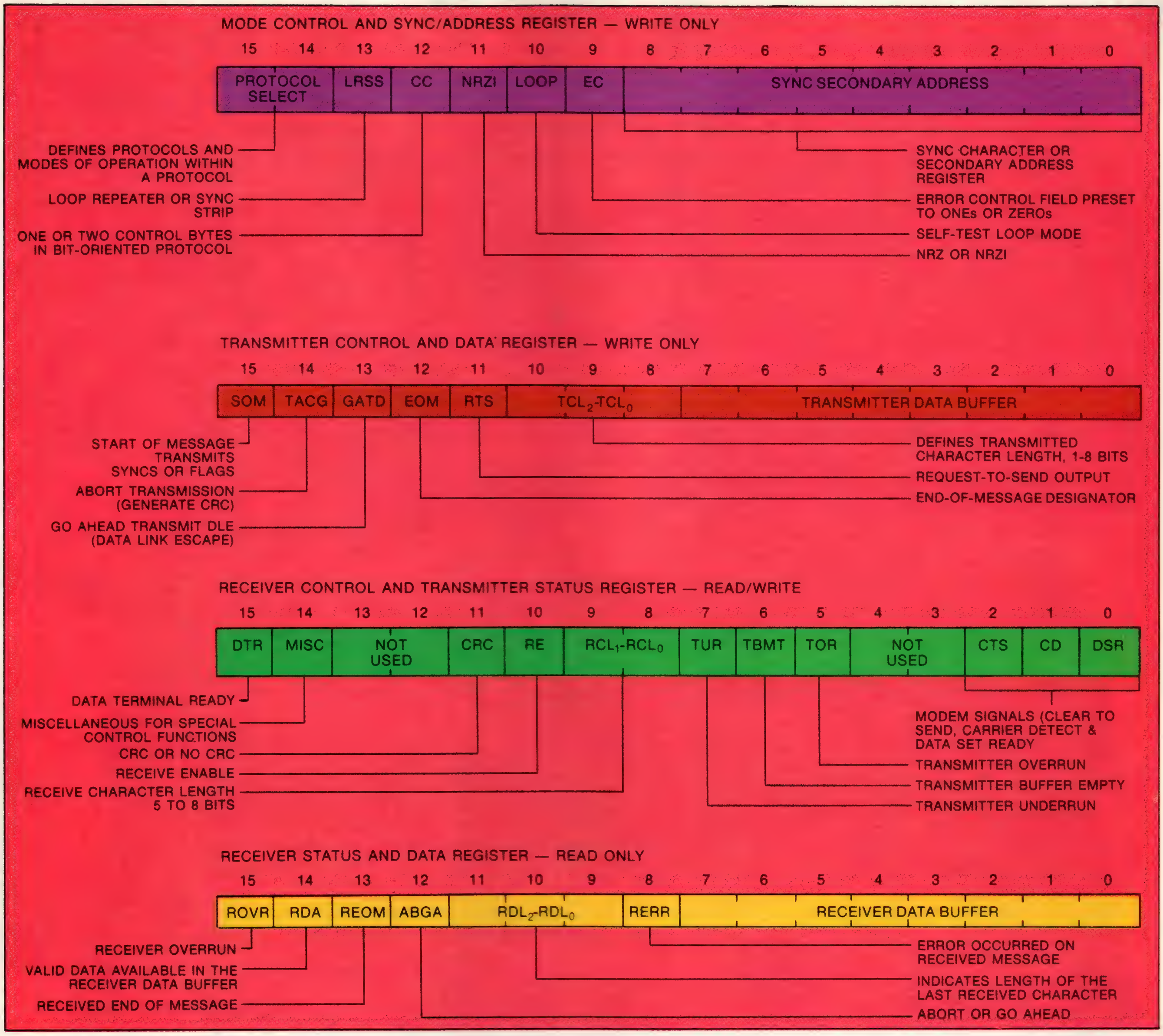
Error control not only helps with error detection but also acknowledges correctly received messages and requests retransmission of messages found to have errors.

Sequence control numbers messages to eliminate duplicates, identifies lost messages and requests retransmission.

Flow control regulates the passage of messages across the link.

Transparency allows the link to treat all transmitted and received information as a pure data stream.

Abnormal-condition recovery is responsible for the actions to be taken when data-terminal equipment detects an "illegal" condition or receives a protocol-defined exception message.


MODE CONTROL AND SYNC/ADDRESS REGISTER — WRITE ONLY
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
PROTOCOL SELECT
LRSS
CC
NRZI
LOOP
EC
SYNC SECONDARY ADDRESS
DEFINES PROTOCOLS AND MODES OF OPERATION WITHIN A PROTOCOL
LOOP REPEATER OR SYNC STRIP
ONE OR TWO CONTROL BYTES IN BIT-ORIENTED PROTOCOL
SYNC CHARACTER OR SECONDARY ADDRESS REGISTER
ERROR CONTROL FIELD PRESET TO ONEs OR ZEROs
SELF-TEST LOOP MODE
NRZ OR NRZI
TRANSMITTER CONTROL AND DATA REGISTER — WRITE ONLY
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
SOM
TACG
GATD
EOM
RTS
TCL_2-TCL_0
TRANSMITTER DATA BUFFER
START OF MESSAGE
TRANSMITS SYNCS OR FLAGS
ABORT TRANSMISSION (GENERATE CRC)
GO AHEAD TRANSMIT DLE (DATA LINK ESCAPE)
DEFINES TRANSMITTED CHARACTER LENGTH, 1-8 BITS
REQUEST-TO-SEND OUTPUT
END-OF-MESSAGE DESIGNATOR
RECEIVER CONTROL AND TRANSMITTER STATUS REGISTER — READ/WRITE
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
DTR
MISC
NOT USED
CRC
RE
RCL_1-RCL_0
TUR
TBMT
TOR
NOT USED
CTS
CD
DSR
DATA TERMINAL READY
MISCELLANEOUS FOR SPECIAL CONTROL FUNCTIONS
CRC OR NO CRC
RECEIVE ENABLE
RECEIVE CHARACTER LENGTH 5 TO 8 BITS
MODEM SIGNALS (CLEAR TO SEND, CARRIER DETECT & DATA SET READY
TRANSMITTER OVERRUN
TRANSMITTER BUFFER EMPTY
TRANSMITTER UNDERRUN
RECEIVER STATUS AND DATA REGISTER — READ ONLY
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
ROVR
RDA
REOM
ABGA
RDL_2-RDL_0
RERR
RECEIVER DATA BUFFER
RECEIVER OVERRUN
VALID DATA AVAILABLE IN THE RECEIVER DATA BUFFER
RECEIVED END OF MESSAGE
ERROR OCCURRED ON RECEIVED MESSAGE
INDICATES LENGTH OF THE LAST RECEIVED CHARACTER
ABORT OR GO AHEAD

3. Bit assignments in each of the four 16-bit, addressable registers can be altered on-line to change the operating protocol. Two of the registers, Mode Control and Sync/Address, and Transmitter Control and Data, are write-only types (a and b). Both the Receiver Control register and Transmitter Status register are read/write circuits (c), while Receiver Status and Data is a read-only type (d).

troller. By providing complete Bisync line-control with its various options, the F6856 reduces the Bisync problem to manageable size.

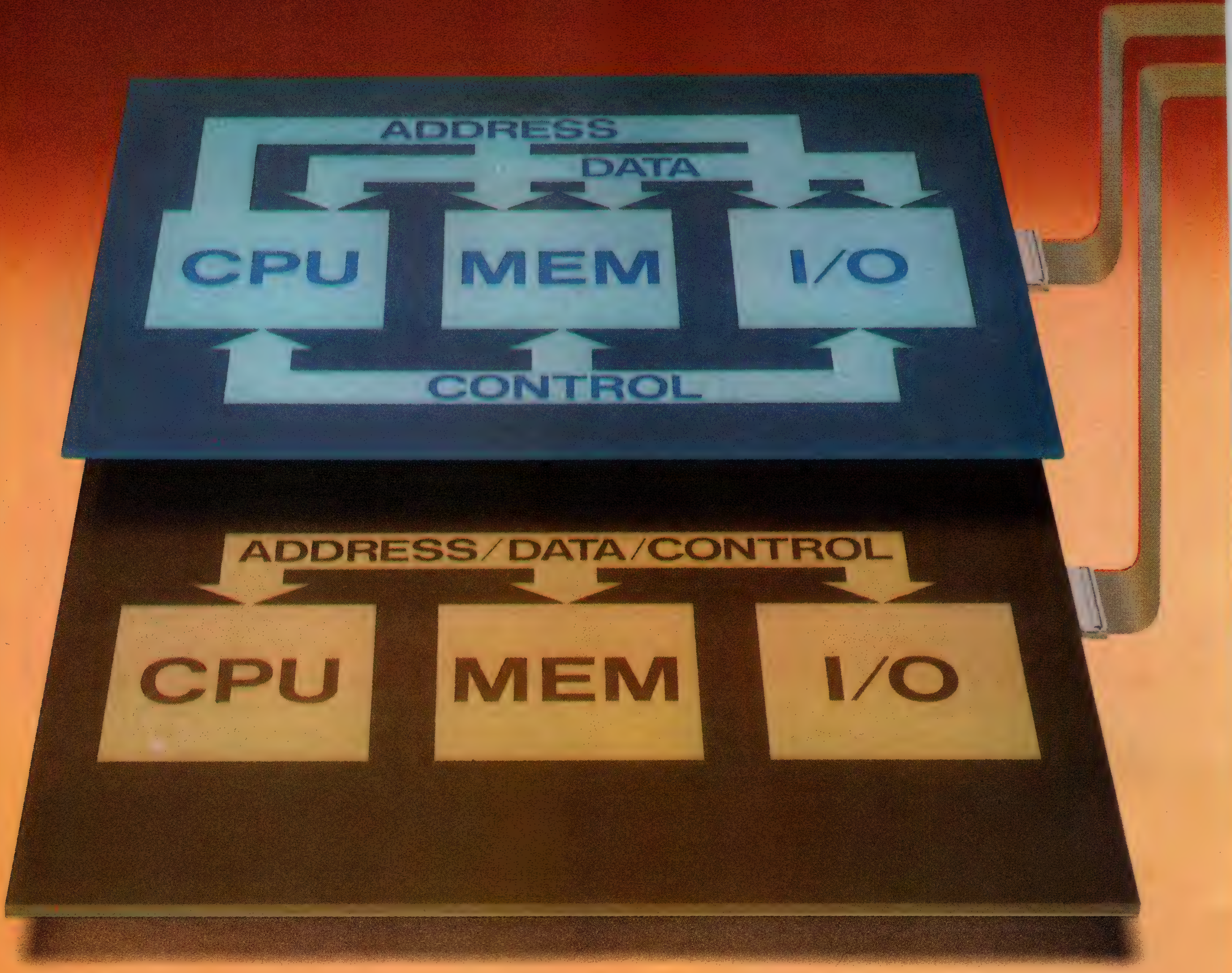
What's more, on-line ability to change protocols and options within a protocol enables the chip to offer full compatibility with both the older and the newer types of protocols. In other words, it provides complete protocol control along with compatibility. This enables the end users to use the same terminals for multiple functions with different networks and applications or on one network conversing with a wide variety of hosts and terminals.

Also, far fewer additional hardware and software resources should be needed for protocol control. Separating the protocol-control functions on the chip itself by means of the four programmable registers not only simplifies system-enhancement tasks but also reduces the possibility of error propagation. In addition, the types of ports provided can be readily reconfigured to meet the changing requirements of communications controllers and concentrators—as they change.

Moreover, with testing fast becoming a major concern in data-comm equipment design, equipment manufacturers are striving to make it as automatic as possible—so simple that testing can be performed remotely whenever possible. On-chip self-test capability can not only facilitate fault diagnosis on an overall-system basis but also help pin down a fault to the malfunctioning component.■■

How useful?	**Circle No.**
Immediate design application	**544**
Within the next year	**545**
Not applicable	**546**

Catch a dedicated or multiplexed bus...



Design Production Service

HP—When you depend on logic

and leave the analyzing to HP's 1610B.

If you're working with mini- or micro-based systems, you'll find that HP's 1610B is a very efficient dedicated-bus logic state analyzer.

But unlike other analyzers, the HP 1610B can also handle multiplexed-bus analysis just as effectively. The reason? Because with multiplexed buses, addresses and data appear at different times on the same lines. And first-generation logic analyzers, with their single-clock design, simply cannot demultiplex these correctly.

One popular solution to this problem has been to build a two-clock sequential acquisition system into a single package. While this approach will separate out address and read/write functions, it is still inferior to the 1610B. Why? Because this is still not true demultiplexing, in that this technique cannot correct for the real-time differential between the capture of address information and the capture of read/write data.

This means address and data information can be interleaved in the display. It requires the operator to interpret read or write functions. And it means that triggering may occur on false address/data combinations. In other words, it complicates analysis and may lead to false conclusions.

In comparison, the HP 1610B incorporates not two — but three clocks — plus a buffered memory to deliver true demultiplexing. In short, the 1610B can independently monitor addresses, plus read and write data, to demultiplex in real time for efficient and accurate analysis.

So with the 1610B, addresses and corresponding data are displayed as a single line of information, for easy comparison with your original programs. And you're sure that if you trigger on an address-data combination, the data is present at that address at that specific point in the program.

Other important capabilities.
In addition, the HP 1610B delivers other capabilities required for efficient state flow analysis of both bus structures. It will store information on a qualified basis, to permit selective editing. Which means you don't have to sort through unnecessary data. And it makes functional measurements, such as time interval analysis, on the state flow, which speeds analysis and troubleshooting.

Flexibility for the future.
Because the 1610B is a 32-bit analyzer with user-selected parameters, and a variety of options, you can use it with both mini and micro based systems, including 8-bit microprocessors such as the Motorola 6800 and the Intel 8085, as well as the newer 16-bit microprocessors such as the Z8000. And, of course, it includes HP's popular menu program format that speeds set-ups and analysis.

An economical solution to microprocessor-based systems analysis.
Another good answer to the problem of microprocessor demultiplexing is the 1611A Logic State Analyzer, with HP's general-purpose module. This module incorporates a seven-clock system that allows multiplexed information on common bus structures to be latched into 1611A inputs at the appropriate time for display. If you're already using an HP 1611A, you'll find this module to be both an effective and cost-efficient solution.

For complete details.
The HP 1610B is priced at $12,500,* while the 1611A (including the general-purpose module) is $6,000.* For more information on these, and for an application note on state analysis of multiplexed microprocessors, write: Hewlett-Packard, 1507 Page Mill Road, Palo Alto, CA 94304. Or call the HP regional office nearest you: East (201) 265-5000, West (213) 970-7500, Midwest (312) 255-9800, South (404) 944-1500, Canada (416) 678-9430.

*Domestic U.S.A. price only

HEWLETT
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CIRCLE NUMBER 44

089/15

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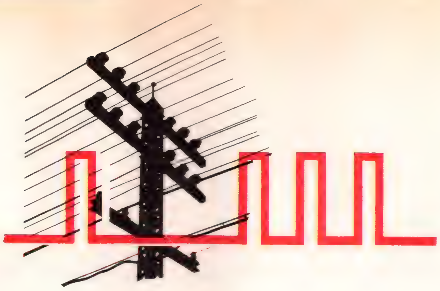


Shared codecs: The quick, easy and low-cost alternative to per-channel chips

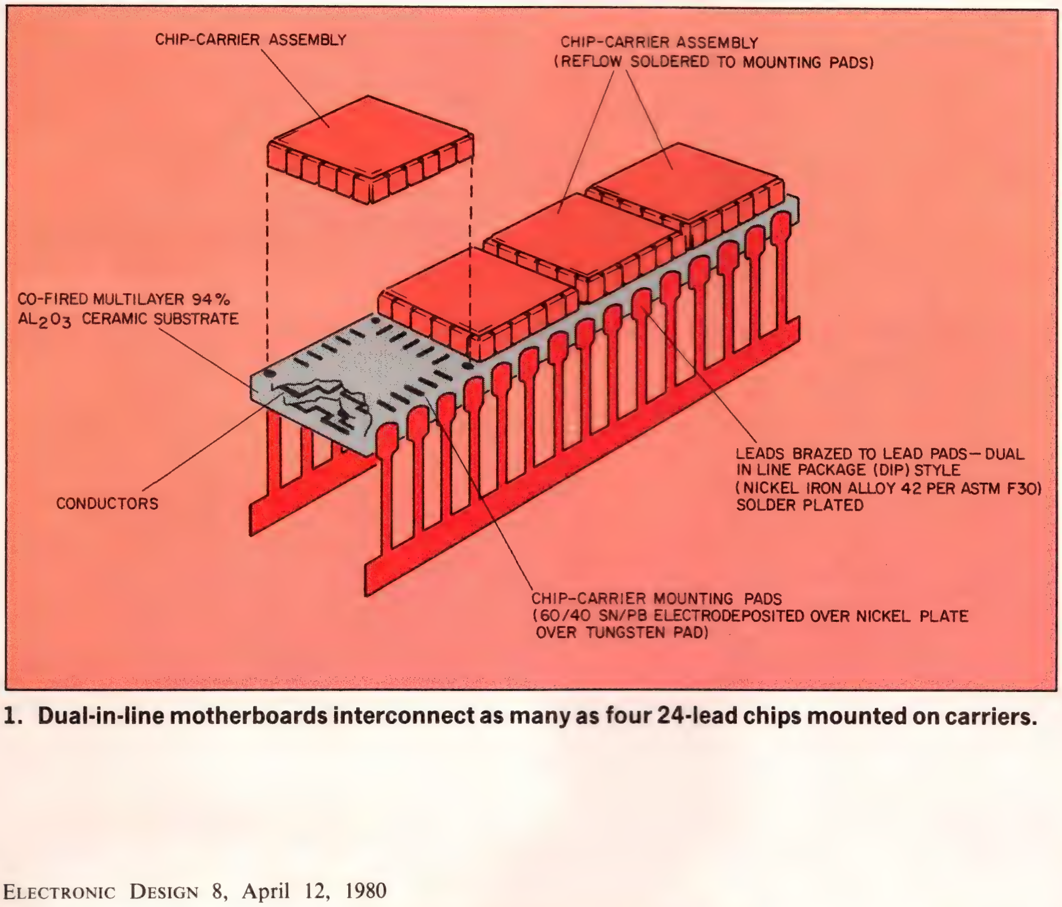
Although MOS and I^2L processes for dense LSIs have swept single-line codecs into popularity, shared-channel codecs—using bipolar LSI—keep costs lower, test out quicker and easier, and prove their versatility in designs closed to one-chip codecs. Advances in bipolar LSIs have spurred the evolution of shared-channel codecs: Discrete transistors and R-2R ladders have given way to such LSI building blocks as multiplexers, sample-and-hold circuits, companded d/a converters and successive approximation registers (see "Baring the Structure of Shared Codecs").

Unlike the shared-channel codecs, single-line codecs nearly eliminate crosstalk, are convenient and may eventually be incorporated into the subscriber set itself; but they are relatively slow. Encoding takes up most of the 125-μs period of the standard 8-kHz sampling. Thus, per-channel chips will probably never handle more than one channel.

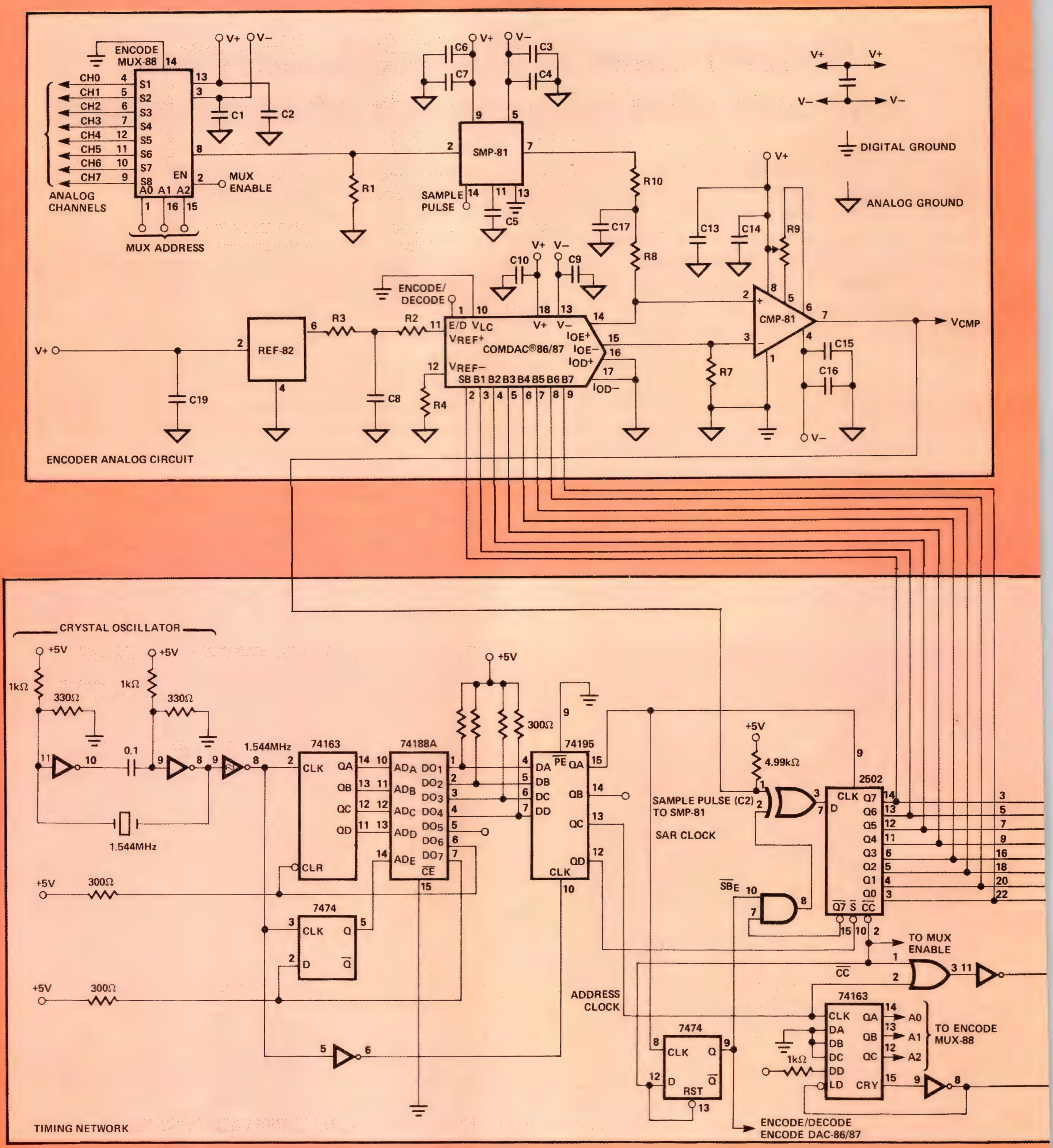
Guido Pastorino, Senior Staff Engineer, Telecommunications, Precision Monolithics, Inc., 1500 Space Park Dr., Santa Clara, CA 95050.

Moreover, single-line codecs are more expensive, primarily because they are larger, than shared-channel codecs. Whether single or shared-channel codecs are used, a 24-channel system needs about 21 packages. But the smaller packages of the shared-channel system save money by using less board space. Also, the cost of monolithic circuits is a nonlinear function of chip area: Cost increases faster than area. The chips within the shared-channel packages can be as small as 3000 sq mils or less. Even the largest is under 10,000 sq mils; but single-channel codec chips range from 22,000 to 40,000 sq mils. Because even more extensive integration is possible, a shared-channel chip could gain three sample-and-hold circuits and still be smaller than the smallest single-channel codec.

On the basis of 100-piece published prices, the ICs in a 24-channel shared-codec system cost $133.85 or $5.58/line. For single-line codecs, the price is $25 to


CHIP-CARRIER ASSEMBLY
CHIP-CARRIER ASSEMBLY (REFLOW SOLDERED TO MOUNTING PADS)
CO-FIRED MULTILAYER 94% AL$_2$O$_3$ CERAMIC SUBSTRATE
CONDUCTORS
LEADS BRAZED TO LEAD PADS—DUAL IN LINE PACKAGE (DIP) STYLE (NICKEL IRON ALLOY 42 PER ASTM F30) SOLDER PLATED
CHIP-CARRIER MOUNTING PADS (60/40 SN/PB ELECTRODEPOSITED OVER NICKEL PLATE OVER TUNGSTEN PAD)

1. Dual-in-line motherboards interconnect as many as four 24-lead chips mounted on carriers.

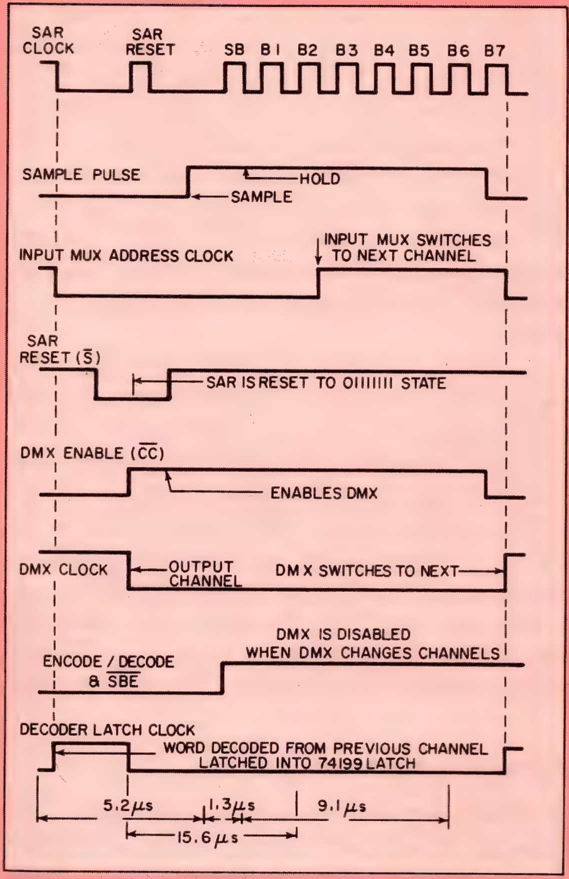

ENCODE
MUX-88
CH0
CH1
CH2
CH3
CH4
CH5
CH6
CH7
ANALOG CHANNELS
MUX ADDRESS
MUX ENABLE
S1
S2
S3
S4
S5
S6
S7
S8
EN
A0 A1 A2
C1
C2
V+
V−
C6
C7
C3
C4
SMP-81
SAMPLE PULSE
C5
R1
R10
C17
R8
C13
C14
R9
CMP-81
VCMP
C15
C16
R7
DIGITAL GROUND
ANALOG GROUND
ENCODE/ DECODE
C10
C9
E/D VLC
V+ V−
VREF+
VREF−
COMDAC®86/87
IOE+
IOE−
IOD+
IOD−
SB B1 B2 B3 B4 B5 B6 B7
REF-82
R3
R2
R4
C8
C19
ENCODER ANALOG CIRCUIT
CRYSTAL OSCILLATOR
+5V
1kΩ
330Ω
0.1
1.544MHz
74163
CLK
QA
QB
QC
QD
CLR
74188A
ADA DO1
ADB DO2
ADC DO3
ADD DO4
ADE DO5
DO6
DO7
CE
300Ω
74195
PE
DA
DB
DC
DD
7474
D
Q
Q̄
4.99kΩ
SAMPLE PULSE (C2) TO SMP-81
SAR CLOCK
2502
CLK Q7
D
Q6
Q5
Q4
Q3
Q2
Q1
Q0
Q̄7 S̄ CC
SBE
TO MUX ENABLE
CC
ADDRESS CLOCK
RST
LD
CRY
A0
A1
A2
TO ENCODE MUX-88
ENCODE/DECODE
ENCODE DAC-86/87
TIMING NETWORK

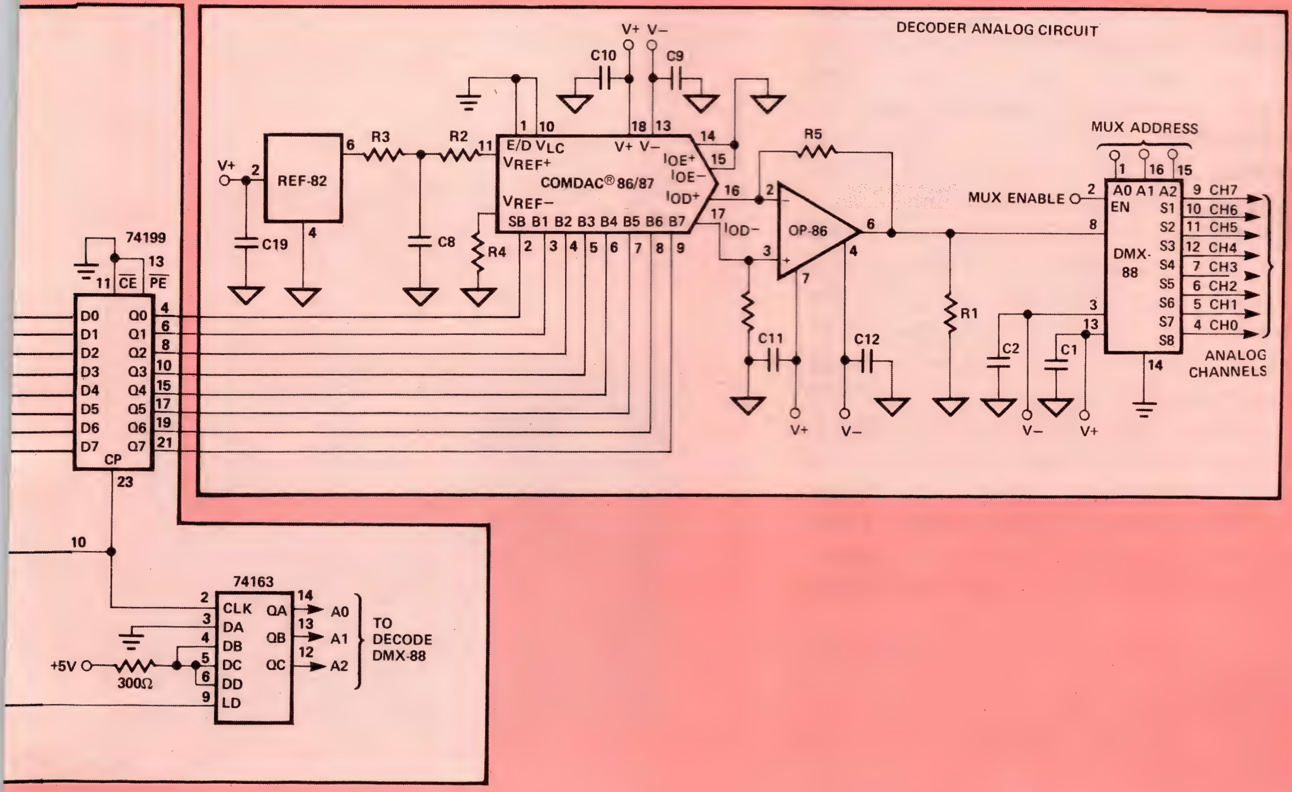
Baring the structure of shared codecs

A simplified, "bare-bones" system pinpoints the concept and the performance features of a shared codec. In the demonstration unit shown in the figure, the auxiliary functions are so simplified that just one 75199 octal latch doubles as the complete transmission system and as the latches for the decoding portion. Auxiliary transmission (which is peculiar to real telephone equipment such as parallel-to-serial and serial-to-parallel conversions, time-slot interfacing and clock recovery) must be tailored to the particular equipment.

The demonstrator is partitioned into three major subsystems that are conveniently constructed on three separate PC cards. One subsystem generates all the timing waveforms shown. Another subsystem encodes the input analog signal, chiefly by means of standard successive-approximation. However, a special clock, generated by the timing network, apportions more time to parts of the encoding cycle that require it. For instance, the earlier series of companded d/a conversions take longer to settle transitions in their lower chords. Hence, the clock allocates more time to the last portion of the encoding cycle where transitions in the low chords are most likely.

A stored program in the 74188A PROM controls the timing, so it is extremely flexible: To alter the timing, simply reprogram the PROM. Detailed operational information is available in application notes from PMI.





$40/line. The difference is not always that great, however. For 100,000 quantities (certainly prudent in some applications of high-volume telco equipment), single-line chip prices will likely drop to the $8-10 range. But in these quantities, the per-line cost of shared-channel parts is approximately $2.50.

Until shared codecs are integrated further, ICs can be assembled into efficient hybrid circuits. One ceramic substrate can hold an entire shared-channel codec. Another method—packaging the shared-codec components in "micropackages"—should debut later in the year.

Micropackages are only slightly larger than the chips themselves and maintain a hermetic seal on the individual components during manufacturing. With micropackages, several 24-channel codecs or both the codec and its filters could fit on a single, medium-sized, PC card. Still another alternative would be to assemble major sections of a 24-channel shared codec (an encoding module, for example) on a motherboard. In this way, an entire 24-channel codec could be assembled on four to six 24-pin packages. Fig. 1 shows a prototype micropackage system and motherboard.

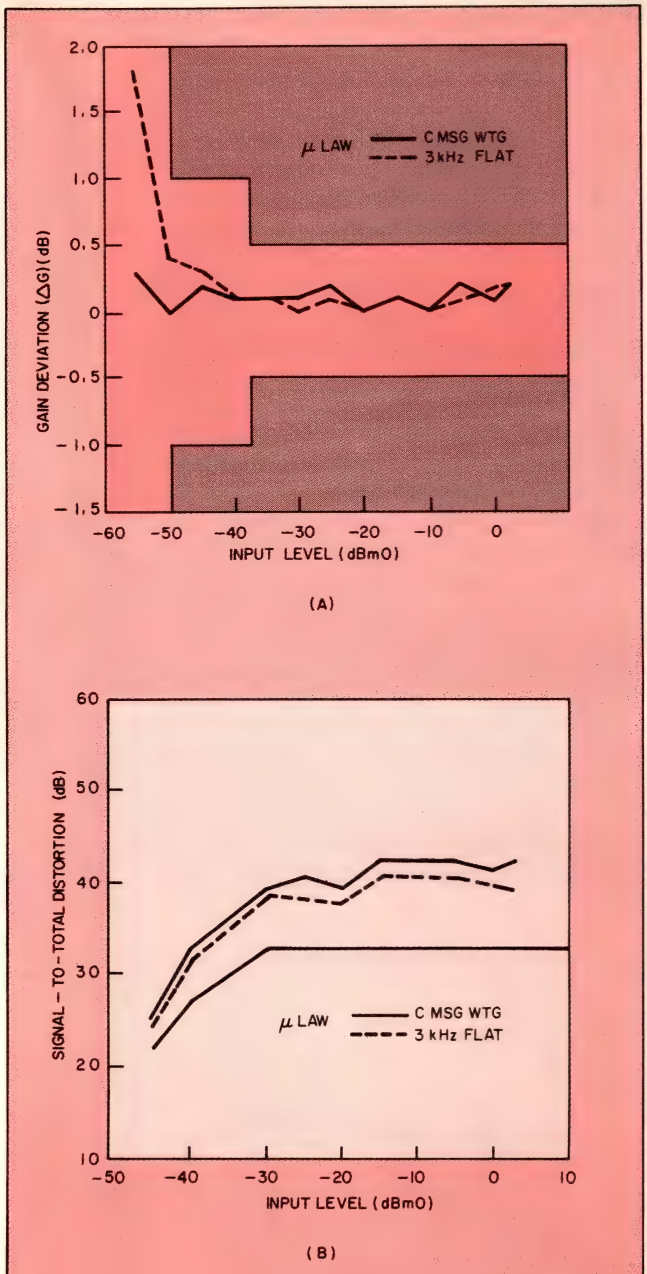
LSI handicaps per-channel codecs

Large-scale integration extracts two penalties from codec systems: Component testing becomes a major cost factor, and versatility is compromised. Both drawbacks are especially true of per-channel codecs.

In spite of the efforts of chip and telecomm-equipment manufacturers, automatic testing of single-chip codecs takes a long time. The problem is that, almost of necessity, such parameters as gain tracking (Fig. 2a), signal-to-distortion (Fig. 2b) and idle-channel noise and crosstalk (Fig. 2c) must be tested end-to-end. This configuration is most demanding.

Testing ratioed-capacitor codecs is always difficult (and time consuming), especially in a loop-back configuration, because only ac testing works, and the drawn-out process must be repeated at the board level. The testing must cover the entire dynamic range because simultaneous errors (in analog subsections such as a sample-and-hold, comparator and operational amplifier or in quantizing circuits such as a ratioed-capacitor subsection) can mask one another over part of the system output. Furthermore, if a unit fails the system test, pinpointing the fault is tedious. To date, all testing schemes for single-channel codec are impractical.

By contrast, the performance of a shared-channel codec system correlates to the performance of its separate components. Thus, the shared-channel codec system tests out quickly and accurately because the component chips, such as the companded d/a converter, can be tested individually, using standard automatic techniques. For evaluation purposes, shared-codec components are no different from standard linear ICs. Less time may be required for testing all the components of a shared-channel system than



(A)

(B)

IDLE CHANNEL NOISE

CHANNEL	NOISE (dBm0)	CHANNEL	NOISE (dBm0)
1	−66.9	5	−62.6
2	−67.6	6	−65.3
3	−67.0	7	−67.0
4	−67.2	8	−61.8

CROSSTALK

FREQUENCY	INTELLIGIBLE CROSSTALK
300 – 2900Hz	<−78dBm0
2900 – 3400Hz	<−70dBm0

(C)

2. Parameters that must be checked by end-to-end methods include gain tracking (a) and signal-to-quantizing distortion (b) vs input level. Idle-channel noise and crosstalk (c) also involve all the channels.

for end-to-end testing of one self-contained codec.

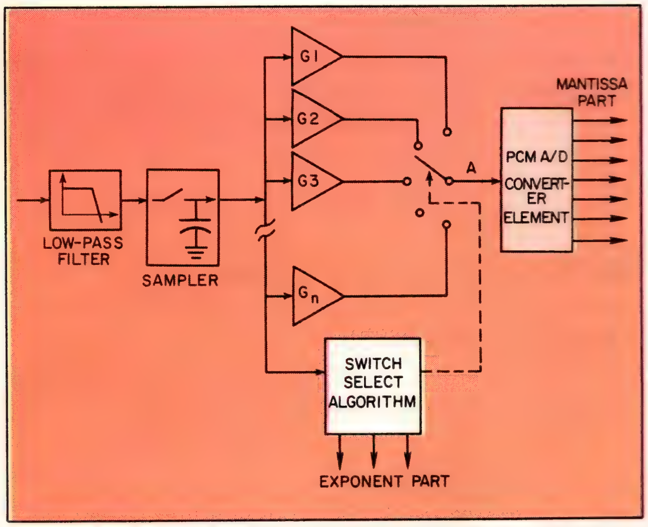
High-levels of integration, without programming options, also result in a loss of versatility (especially for one-chip codecs). However, a shared codec keeps its versatility—its data output, for example can be either serial or parallel. Parallel outputs mate easily with an 8-bit transmission bus. An 8-bit parallel system could be useful in transmitting data and voice over the same lines, or for interfacing with μP-based equipment. A shared-codec system can be partitioned in several configurations, giving equipment designers additional flexibility.

Shared codecs carry the conference

With shared-channel codecs, designing in the capability to conference received calls is easy. This feature is important in PABX design. The popular techniques for conferencing are:

- Adding analog voice signals together in a conventional linear circuit
- Mixing amplitude-modulated pulse (PAM) trains from several channels
- Adding the binary data from two linearly-encoded voice channels.

Shared-codec systems are well-suited to the PAM and linear binary-addition methods.



3. Floating-point conversion may be performed using a standard PCM converter to produce the mantissa; a switch-select algorithm that optimizes the preconversion gain generates the exponent.

When PAM trains are to be mixed in a shared-codec system, the receiving multiplexer is designed so that each channel receives all the conferenced time slots. For instance, suppose slots 1, 2 and 3 represent channels 1, 2 and 3, respectively. To form a conference call with these three channels, each channel must receive pulses from the other two time slots; for example, channel 2 must receive pulses from time slots 1 and 3.

In conferencing two digitized channel, companded digital signals are converted to their linear equivalents. The numerical value of each word is halved, by shifting-right one bit, and then the binary-coded signals are added linearly. In some PBXs, the carrier need not conform to TI standards, and linear encoding may be more convenient. If the signal does not interface with a central-office, the linear-to-companded transformation can be skipped. For such systems, shared-channel codecs featuring linear encoding and decoding will soon be available.

Even with companding, 8-bit parallel busing can make data easier to process. If companded data must be linearized, a parallel input bus is more efficient than a serial input to the decoder. Also, with a parallel input, a companded-to-linear transformation matrix can be coupled with a 12-bit linear d/a converter for decoding only.

Some telephone channels are used for wideband high-quality signals, like music. Shared-codec systems encode wideband signals simply by trading the number of channels encoded for bandwidth. An eight-channel shared-codec system will easily pass a 30-kHz signal, if the input multiplexer is bypassed and the sample-and-hold circuit is driven directly from a 30-kHz anti-aliasing filter.

For a dynamic range wider than the 72 dB normally provided by a companded 8-bit system, additional channels further compand the signal. For instance, an 8-bit word can be followed by a second word that provides information for floating-point conversion. Floating-point conversion requires gain stages that conform to a switch-select algorithm, in front of the PCM converter element. The selected switch generates a code that is transmitted by using additional bits. Fig. 3 illustrates this companding technique. The switch-select algorithm code is the exponent and the a/d converter output is the mantissa.▪▪

Bibliography

Blesser, Barry A., "Digitization of Audio: A Comprehensive Examination of Theory Implementations and Current Practice," *J. Audio Eng. Soc.*, Vol. 26 (Oct. 1978), p. 739.

Berry, B., "Eight-channel Codec Demonstrator," Application Note AN-37, AN-38, Precision Monolithics, 1979.

How useful?	**Circle No.**
Immediate design application	**547**
Within the next year	**548**
Not applicable	**549**

Why telecom majors

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All the major manufacturers of telephone station apparatus who have converted to IC dialers have designed in the Mostek dialer circuits. Why? One reason is commitment. Mostek's commitment to leading-edge integrated dialer technology and product availability.

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CIRCLE NUMBER 74

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Product	Features
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MK50982	Direct telephone line operation. Last number redial. Ceramic resonator for frequency reference. 16-pin.
MK50991	Direct telephone line operation. Last number redial. Mute output interfaces with bistable latching relay. 18-pin.
MK50992	Direct telephone line operation. RC oscillator for frequency reference. Last number redial. 18-pin.

MOSTEK'S TONE DIALER FAMILY

Product	Features
MK5087	Direct telephone line operation. Muting and tone amplitude regulation on chip. Form A or 2-of-8 keyboard. 16-pin.
MK5089	Interfaces easily in electronic or µP dialing applications. Output tone level is a function of supply voltage. Tone Disable input. 2-of-8 keyboard. 16-pin.

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Telecommunication

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Induced lightning can be characterized by impulses having a 10 x 1000 μsec waveform with a typical rise time of 500 V/μsec. Pulses of 5000 V with peak currents of 50 Amps are not uncommon during electrical storms. Lightning arrestors, such as spark gaps and gas discharge tubes, have specific response characteristics which permit enough energy to 'leak' into an electronic system to cause failure. For reliable secondary protection, we recommend our new low cost JEDEC registered 1500 W series TransZorb® transient voltage suppressors. They're 100% tested to the 10 x 1000 waveform. The 1N6267 series covers a 6 V to 200 V range and is available from stock."

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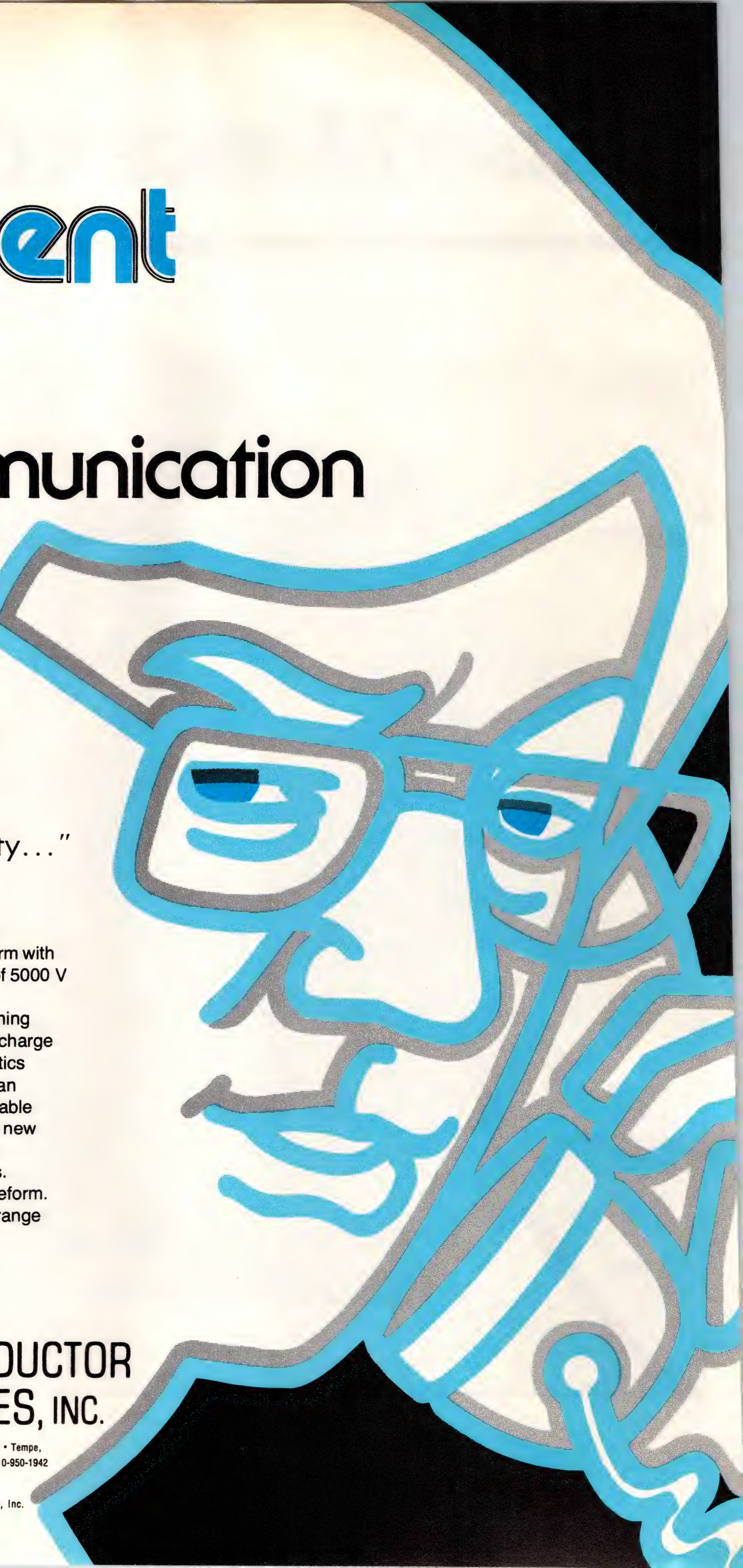
CIRCLE NUMBER 47



Team an array processor with a μP for super performance in data comm

When digital processing systems must race through high volumes of data in real time, one configuration performs as well as a superminicomputer yet saves cost, weight, power and space: an array processor teamed with a host microprocessor. Most signal processing systems incorporating an array processor require a minicomputer or mainframe as the host computer, and customized circuitry. With an array processer that can interface directly to signal (or data) input and output, manage the signal processing under the supervision of its own internal microprocessor and send data out to the host at a reduced rate, a small microprocessor suffices as the host.

Analogic's AP400 array processor depends on the host processor merely to handle the control and interface between the signal processing system, the other peripherals (such as mass storage media) and the operator interfaces. As a spectrum analyzer, for example, or as part of a spread-spectrum radiotelegraph communications link, the AP400 processes signals faster than a minicomputer can process the equivalent mathematical equations.

Other advantages of the array processor and microprocessor team are:

- Flexibility—both architecture and processing can be changed with software
- The use of off-the-shelf hardware and software, instead of customized circuits
- Quick prototyping for field trails
- Reusability in other systems.

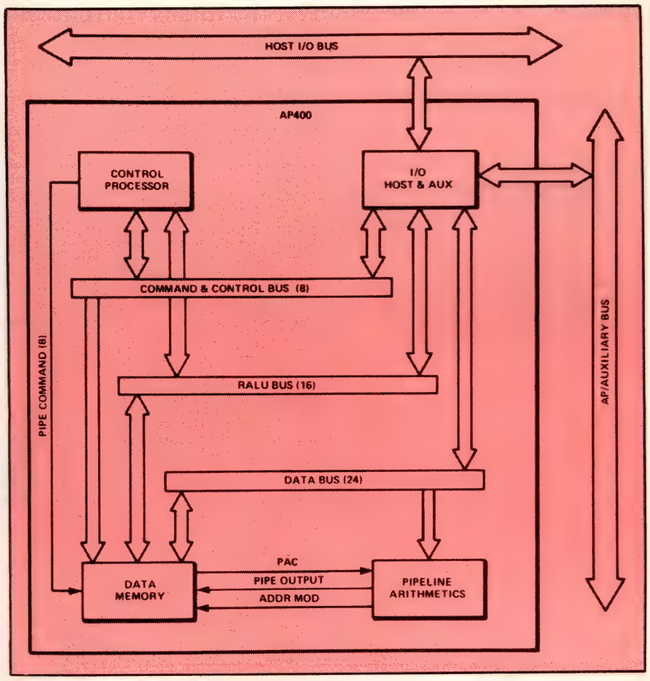
The host and array processor communicate by both programmed I/O (PIO) and direct memory access (DMA). Within the array processor, these interactions are controlled by a microprocessor-based controller.

The architecture of the AP400

The architecture of the AP400 array processor centers on the control processor and its AM2901 bit-slice microprocessor (Fig. 1). The AP400 also contains a pipeline arithmetic unit (see "The Number-Crunching Muscle of the AP400"), interface I/O, data memory, and host and auxiliary I/O.

Harold Messias, Product Marketing Manager, and **Bruce McKeever,** Principal Engineer, Analogic Corp., Audubon Rd., Wakefield, MA 01880.

As the central processing unit for the array processor, the control processor executes and links programs (including parameter and initial condition passing) and handles programmed flag conditions and interrupts. It interprets host-generated commands and instructions and sets up lists of addresses and commands for processing by the pipelined arithmetic unit. The control processor includes a 16-Register-File Arithmetic and Logic Unit (RALU), program counter, program memory address register, command and instruction decoder, status bit register and interrupt vector encoder. The control processor communicates with other parts of the array processor primarily by



1. Within the AP400 array processor, the high-speed arithmetic unit processes the signal (or data); the control processor sets up the pipeline and data flow; the interface I/O handles communications between the array processor and its host and auxiliary ports; the data memory stores data between processing steps; and the host and auxiliary I/O ports input or output data directly to the data memory.

an internal bus that is transparent to the user.

The interface (I/O) provides for all the communications between the array processor and its host and auxiliary ports. It transfers data under programmed I/O or DMA transfer modes, and accesses specified areas in the array processor for diagnostic testing.

Data memory is required in an array processor to provide a storage space for data either between processing steps or during an I/O data-formatting sequence. Most array processors have a data memory of up to 64 kwords. Because the data memory is inside the array processor, transfers between the host and the array processor are avoided during the processing of data. Overall system throughput slows down with each transfer of data between the host and the array processor.

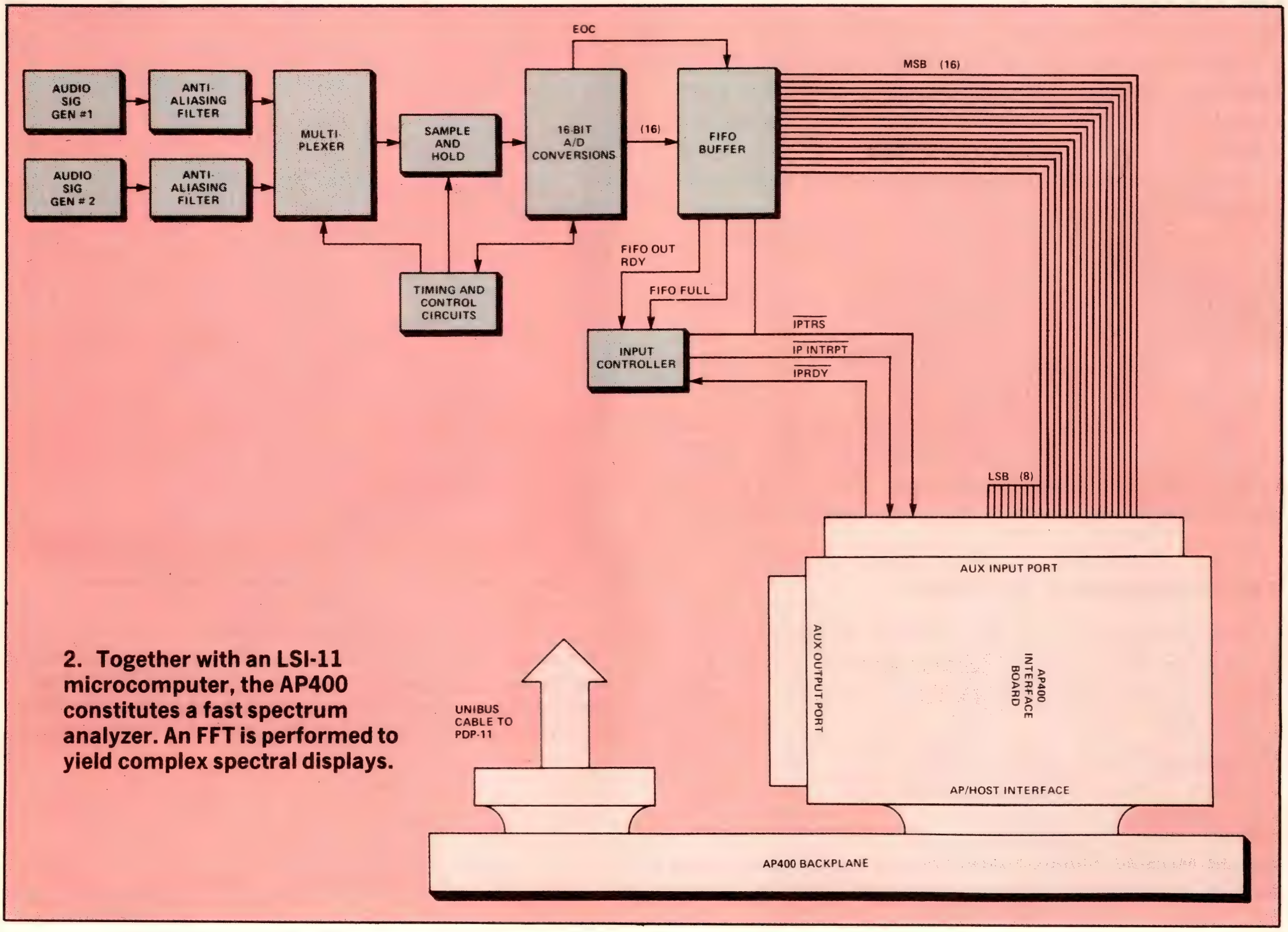
The memory within the array processor partitions incoming data (waveforms) into segments (arrays, vectors) that can each be processed by the arithmetic unit in repetitive groups of operations. As one segment of data is being processed, the next segment is being read into the memory.

The AP400's auxiliary I/O (AUX I/O) port is a flexible interface that can input or output data directly to the array processor's data memory. The auxiliary input provides all the interface required to a data acquisition system, which (in turn) interfaces to sensors or transducers. The auxiliary output interfaces to a digital or analog subsystem, which (in turn) interfaces to either a display or a control subsystem. The interface may be used in a burst or a continuous processing mode.

Putting the array processor to work

In Fig. 2, the AP400 is configured together with Digital Equipment Corp.'s LSI-11 microcomputer to perform a spectrum analysis of two audio signals connected to the input of a data-acquisition subsystem. Spectral analysis involves reading a continuous stream or a burst of data into the array processor, which then processes this data while the next data segment of the audio waveform is being read in. The data-acquisition subsystem consists of the antialiasing filters for each channel, a multiplexer to switch between channels, a sample-and-hold module, a 16-bit a/d converter, and the associated timing and logic circuits. The controller and first-in/first-out (FIFO) buffer provide inputs to the array processor for a specific I/O routine.

Each of the two audio signals is digitized in real time; data are transferred to the array processor; a Fast Fourier Transform (FFT) is performed on the signals; the complex magnitude of the signals and the logarithm of the magnitudes are computed; and the data are transferred continuously to the host. The host



2. Together with an LSI-11 microcomputer, the AP400 constitutes a fast spectrum analyzer. An FFT is performed to yield complex spectral displays.

The number-crunching muscle of the AP400

High-speed digital signal processing is a factor in image processing, speech processing, computer-aided design and many other areas where high volumes of data must be processed in real time. These digital processing applications require high-speed arithmetic operations for convolution, filtering, matrix inversions, coordinate conversion, interpolation and geometric rectification. An array processor, teamed with a host microprocessor, can provide the required high-speed digital arithmetic processing.

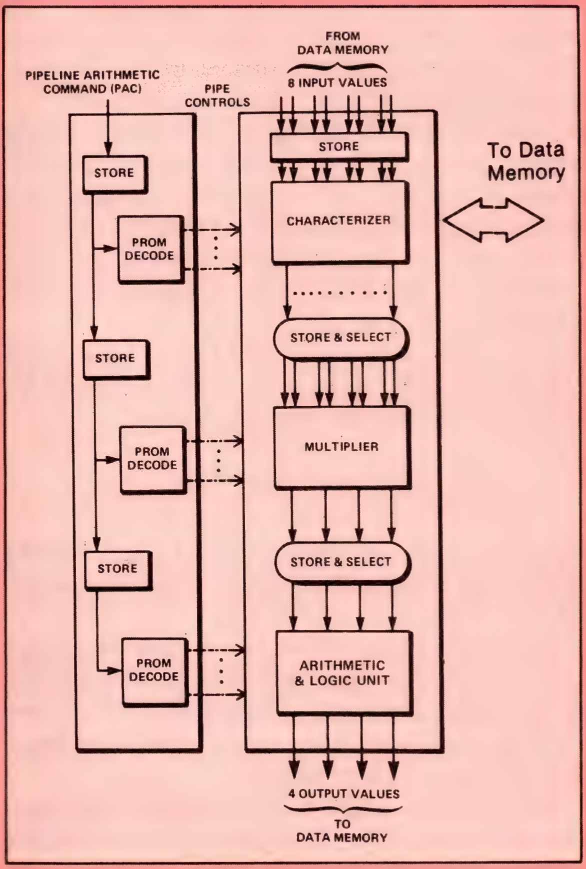
Array processors differ in how their arithmetic units are implemented, but in all cases, the arithmetic unit supplies the number-crunching muscle. One way to increase the throughput when processing arrays of data is to parallel complete arithmetic units and to partition the data among them. This technique is costly in terms of hardware. It also causes programming complexity associated with maintaining correct synchronization among parallel units and in combining partial and final results. Another way to increase throughput is to partition the arithmetic unit into stages and to introduce new data inputs to the first stage as soon as the previous data move to the second stage. This is the technique used in the AP400. The three-stage pipelined arithmetic architecture (see Fig.) is the basis for its high-speed processing ability. The three pipeline stages and their functions are:

- Characterizer stage (a versatile data conditioner): prepares multiplier and multiplicand inputs from source data or from tabular data indexed by the source data.
- Multiplier stage: multiplies selected multipliers and multiplicands with optional accumulations of partial products.
- Arithmetic and logic stage: performs arithmetic and logic operations on selected multiplier outputs, including accumulations, additions, subtractions, logical comparisons and normalization functions.

To increase the efficiency of such partitioning, the configurations of each stage and the passing of data between stages are under program control. Each stage performs several variations of its basic function. Control signals (decoded from a program in the microprocessor-based control processor) configure each stage so that the appropriate inputs are selected, and the desired instructions are performed. A storage and selecting function between stages acts as a type of controlled cross-bar switch, to select the four pairs of multipliers and multiplicands for the multiplier stage from the inputs of the previous stage.

It takes twelve clock cycles for data to pass through any stage. Since the AP400 operates with a 160-ns clock, it takes 1.92 μs to process data in any stage. As an example, four multiplications and four accumulations can be performed by the multiplier stage in one of its programmed configurations. The effective multiplication rate is 480 ns per multiplication and approximately 4 million arithmetic computations per second, in this stage alone. Approximately 2 μs are required to pass data through each stage. At the end of 6 μs, the first output of the pipeline is realized. Thereafter, new outputs occur every 2 μs, as long as the pipeline is kept full.

All timing estimates for processing within the array processor are determined by what can be done by the pipeline in a single pass of input data. As an example, it takes two passes through the pipeline to compute the logarithm of a 24-bit input data word, and two of these functions can be done in parallel. Computing the logarithms of a 1024-word data set takes just 2 ms—faster than almost any microprocessor used alone.



microcomputer then transfers the results to a display subsystem which shows the spectral density of each of the two original signals.

In real-time continuous signal processing, the time needed for inputting, processing and outputting the data determines the maximum signal bandwidth that can be used for the system.

In the AP400, the input and output operations of the host and the AUX I/O overlap with pipeline-arithmetic processing operations. Overlapped operation utilizes the concept of cycle stealing: Pipeline processing is delayed for one machine cycle every time an I/O operation requires access to the data memory. In determining the processing time with overlapped I/O, the processing time required for a given number of data points in first estimated without overlapped I/O, by determining the number of passes through the pipeline needed for each processing function.

As an example, the array processor performs a 512-point real FFT computation on incoming data; the data are reordered, the complex magnitude is computed, and the results are output to the host. The non-overlapped processing time would be 6511 µs.

Next, the number of delayed cycles caused by the overlapping is determined. In the example, pipeline processing is delayed by 1 cycle (160 ns) each time a word is brought into data memory from the auxiliary input port and each time a word is transferred from data memory to the host. This increases the total processing time to 7097 µs.

Finally, the allowable input data rate is determined by dividing the total number of words processed by the total time needed for the processing, or:

$$\frac{2 \times 512}{7.097 \times 10^{-3}\ \text{s}} = 144\ \text{kHz}.$$

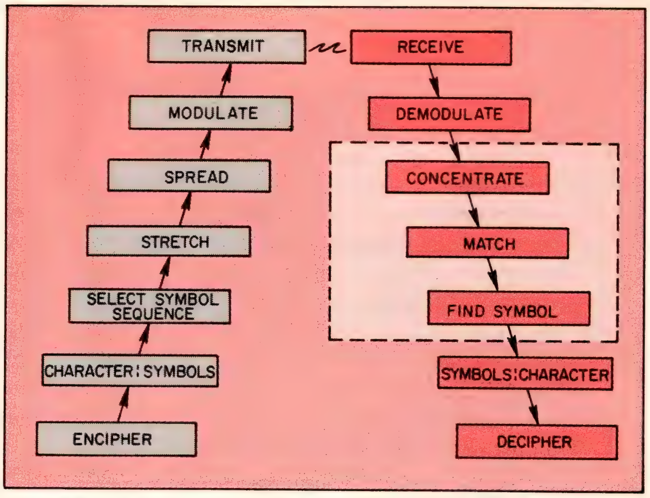
The input data rate per channel is 72 kHz, providing a maximum input signal bandwidth of approximately 35 kHz per channel.

The auxiliary input port can also operate in a burst mode. For stochastic signal processing, an adequate sample of the data defines the information for all time intervals, and a burst mode can be used for input without losing any information.

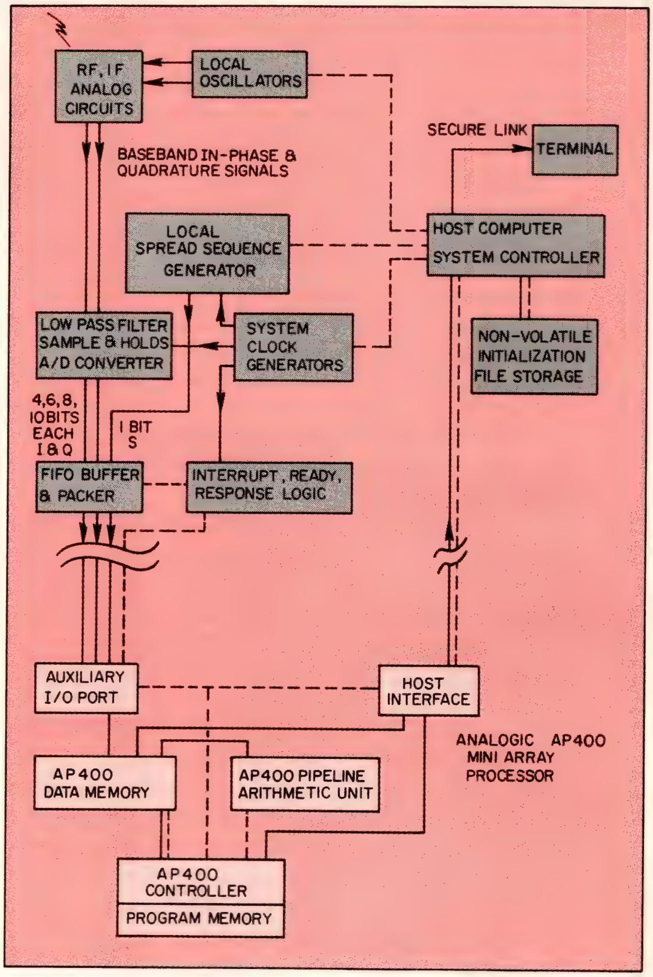
An AUX I/O interrupt service routine that continually recycles for a predetermined number of cycles would be used for this type of processing. The AUX I/O interface requires three machine cycles or 480 ns to transfer a 24-bit word to data memory. Because the AUX I/O is third in priority for use of the memory bus, the bus will not always be available when AUX I/O wants to transfer data. Making the AUX I/O wait for every transfer adds two additional cycles to the transfer time. If the bus is available to AUX I/O 50% of the time, then one additional cycle would be added (on the average), and the input data rate for this mode would be:

$$1/640\ \text{ns} = 1.5\ \text{MHz}.$$

The array processor can also implement the transmitter and receiver in a phase-keyed, spread-spectrum



3. An array processor can handle many of the transmitting and receiving functions in a phase-keyed, spread-spectrum radiotelegraph communications link. Concentrate, match and find involve the greatest amount of processing.


RF, IF ANALOG CIRCUITS
LOCAL OSCILLATORS
SECURE LINK
TERMINAL
BASEBAND IN-PHASE & QUADRATURE SIGNALS
LOCAL SPREAD SEQUENCE GENERATOR
HOST COMPUTER SYSTEM CONTROLLER
LOW PASS FILTER SAMPLE & HOLDS A/D CONVERTER
SYSTEM CLOCK GENERATORS
NON-VOLATILE INITIALIZATION FILE STORAGE
4,6,8, 10 BITS EACH I & Q
1 BIT S
FIFO BUFFER & PACKER
INTERRUPT, READY, RESPONSE LOGIC
AUXILIARY I/O PORT
HOST INTERFACE
ANALOGIC AP400 MINI ARRAY PROCESSOR
AP400 DATA MEMORY
AP400 PIPELINE ARITHMETIC UNIT
AP400 CONTROLLER
PROGRAM MEMORY

4. Accepting digitized samples directly, the array processor handles the heavy processing functions in a digital receiver faster than a µP acting alone.

radiotelegraph communications link (Fig. 3). A spread bandwidth increases a transmitted signal's resistance to interference.

In transmitting, the enciphered message is broken down into a sequence of transmission symbols, each of which is paired to a set of orthogonal marks by the array processor. Each mark is duplicated to stretch the time base and therefore reduce the bandwidth associated with the symbol. A pseudo-random generator modifies the duplicated mark stream of each symbol, and the symbol bandwidth is spread over a larger channel bandwidth. The spread, duplicated stream of symbol marks is used to phase-modulate a carrier, and is transmitted. At the receiving end, another array processor demodulates and samples the received signal-plus-noise.

Spreading a transmitted signal

As an example, eight marks are associated with a symbol at the transmitter. Each mark is duplicated eight times and modified by a 64-bit psuedo-random spread sequence. At the receiver, the demodulated in-phase and quadrature signal plus noise is sampled at 10.24 kHz, producing 4 samples per transmitted mark or 256 samples per symbol. A 12.5% uncertainty is allowed on the time of arrival, so that 32 possible times must be measured around the actual time of arrival to locate the symbol.

The AP400 array processor runs fast enough so that, after it receives the symbols, only 13 ms of processing is needed before the symbol, its actual time of arrival and its correlation are sent to the host. The data rate is cut from 861 numbers each 28 ms arriving at the AP400, down to three numbers going to the host computer.

The major elements of a digital receiver (Fig. 4) are the analog circuits, control logic, array processor, system controller and terminal. Since the local oscillator and the signal are not phase locked, bi-phase demodulation produces in-phase (I) and quadrature (Q) signals which, after some processing, will be envelope-detected to get rid of the synthetic phase.

The baseband signals go through low-pass filters to sample-and-hold amplifiers that feed an a/d converter. Samples of I and Q signals are packed with the output of the local spread-sequence generator, into the 24-bit AUX I/O port of the array processor. The plug-in a/d modules produce 4 or 6 bits and can expand to 8 or 10 bits. The FIFO buffer can hold 16 samples plus at least 2 "guard" samples for the AUX I/O. Thus, the overhead for I/O service is minimal.

The host controls the local rf and i-f oscillators to coincide with the channel being used; controls the local spread-sequence generator (SSG) to coincide with the transmitter's SSG at the time of transmission; and uses advance/retard control to keep the estimated time of arrival (ETA) of each symbol in the middle of an uncertainty window. The host also controls the system-clock generator, which in turn controls sampling, packing and loading of the FIFO and the logic to start acquiring samples for a symbol, plus the guard and logic to drive the AUX I/O interface.

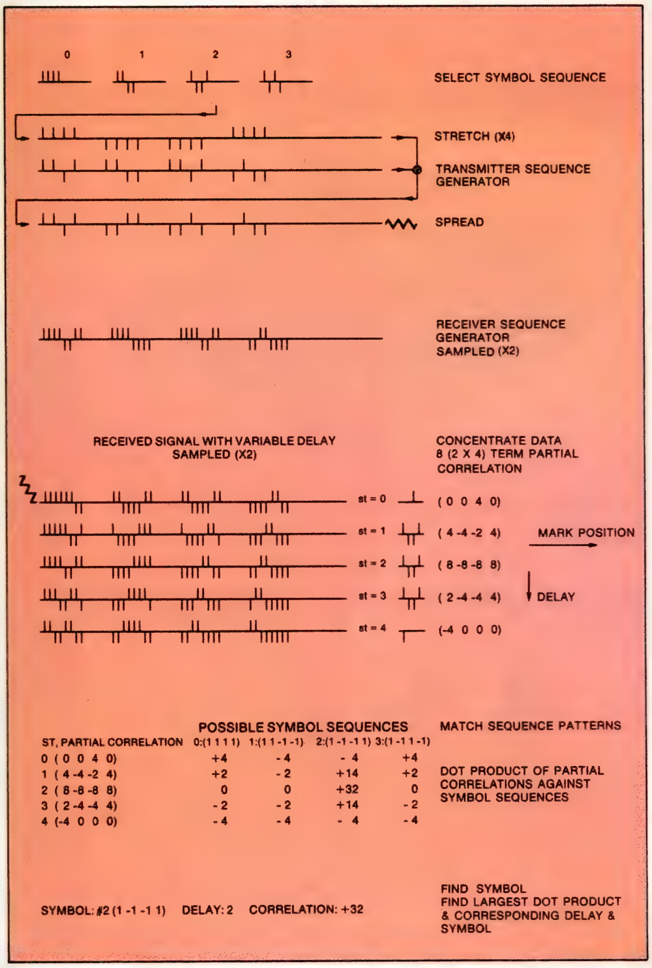
While physically, modulation involves phase shifting by $\pm\pi/2$ (or $0,\pi$), it might be helpful to visualize the signal (S) as ±1 marks multiplied by other ±1 marks with duplication (Fig. 5). At the transmitter, the selected symbol was stretched by duplicating marks (in the diagram, ×4). The transmitter's spread-sequence generator multiplied to do the spreading. The result was ultimately transmitted.

At the receiver, the local SSG is adjusted for the transmission delay to coincide with the transmitter SSG at transmission time. The incoming signal and the receiver SSG are sampled two times per mark.

At the transmitter, spreading involved $S(=\pm1) \times$ stretch marks. At the receiver, when the signal is delayed by the right amount:

$S_r(=\pm1) \times S_t(=\pm1) \times$ stretch marks $= (\pm1)^2 \times$ stretch marks = stretch marks.

(continued on page 120)

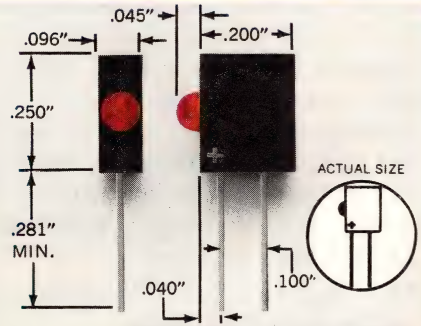

0
1
2
3
SELECT SYMBOL SEQUENCE
STRETCH (X4)
TRANSMITTER SEQUENCE GENERATOR
SPREAD
RECEIVER SEQUENCE GENERATOR SAMPLED (X2)
RECEIVED SIGNAL WITH VARIABLE DELAY SAMPLED (X2)
CONCENTRATE DATA 8 (2 X 4) TERM PARTIAL CORRELATION
st = 0
(0 0 4 0)
st = 1
(4 -4 -2 4)
MARK POSITION
st = 2
(8 -8 -8 8)
st = 3
(2 -4 -4 4)
DELAY
st = 4
(-4 0 0 0)
MATCH SEQUENCE PATTERNS
DOT PRODUCT OF PARTIAL CORRELATIONS AGAINST SYMBOL SEQUENCES
FIND SYMBOL
FIND LARGEST DOT PRODUCT & CORRESPONDING DELAY & SYMBOL

	POSSIBLE SYMBOL SEQUENCES			
ST, PARTIAL CORRELATION	0:(1 1 1 1)	1:(1 1 -1 -1)	2:(1 -1 -1 1)	3:(1 -1 1 -1)
0 (0 0 4 0)	+4	-4	-4	+4
1 (4 -4 -2 4)	+2	-2	+14	+2
2 (8 -8 -8 8)	0	0	+32	0
3 (2 -4 -4 4)	-2	-2	+14	-2
4 (-4 0 0 0)	-4	-4	-4	-4

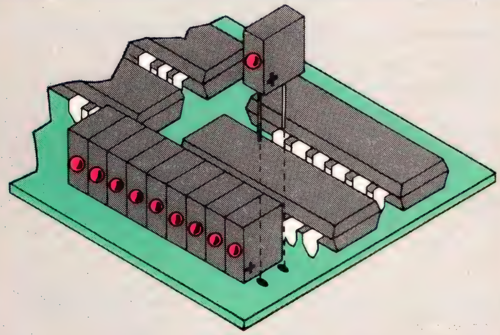
SYMBOL: #2 (1 -1 -1 1) DELAY: 2 CORRELATION: +32

5. To clarify the functions handled by the array processor, the waveform is considered to be a ±1 mark, multiplied by other ±1 marks.

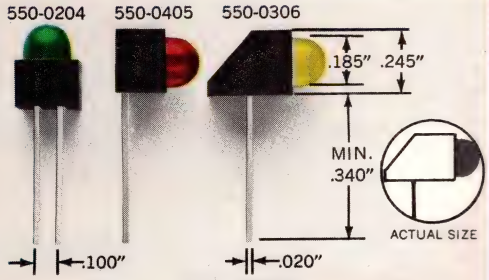
Dialight LEDs



555 SERIES LED logic state indicators available in 14 models with voltage ratings from 1.7 to 14. Suitable for dense packaging on printed circuit boards—up to 10 units to the inch—IC compatible. With built-in resistor. Polarity identified. Low power consumption. With pricing as low as .57¢ (1000 lot quantity).



These low cost LED logic state indicators are extremely versatile devices and lend themselves to a wide range of applications. Digital status indicators and circuit fault indicators are typical applications.



550 SERIES Mix 'em or match 'em. LED logic state indicators are available in red, yellow and green, in a variety of shapes, some with a built-in resistor. Can be driven from DTL and TTL logic. Designed for easy alignment on PC boards. Also available with high brightness LEDs. With pricing as low as .32¢ (1000 lot quantity).

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CIRCLE NUMBER 48

Since the stretch duplicated marks, adding adjacent products (2 samples per transmitted mark × 4 transmitted marks per symbol mark) amplifies each symbol mark when the signal is delayed by the right amount. Because the right delay is not known exactly, the multiply-add must be repeated for each allowed delay.

Each ±1 of the receiver SSG is multiplied with the corresponding ±1 in the sampled signal in groups of 8 and the result is accumulated for each Δ t=0 to 4. This produces the tentative four-mark groups shown in Fig. 5, as a function of delay. A visual comparison of the four-mark sequence at Δ t=2 with the possible symbol sequences at the transmitter would show a good match with the selected symbol and with no others. The detected marks at Δ t=1&3 show some slight resemblance, while the detected marks at Δ t=0&5 do not fit at all.

In the AP400, the equivalent to this visual comparison is to match the partial correlation results (the detected marks) by a dot product against each possible pattern of symbol sequences. The diagram shows the score or correlation value ranging from −4 to +32, with the high scores reflecting what humans can see for themselves, but not as quickly as the AP400—that a particular correlation and a possible symbol sequence are very much alike.

Finally, the symbol and actual-time-of-arrival corresponding to the highest correlation value are found by searching for the maximum correlation and keeping track of the lag and symbol number. A simple repetitive search might do in some cases. However, a faster process is to compare pairs of data, storing only the result with the highest correlation value, and then continuing to make (and select from) successive pairs in tree fashion, culminating in the value of the maximum correlation.

The actual-time-of-arrival of a symbol differs from the ETA because of such factors as variations in the transmission path and drifts in the carrier-frequency generators. The digital receiver measures the time of arrival of each symbol, and uses this measurement to alter the ETA with the appropriate time constant. By measuring the probability of each symbol match, as compared to that with a perfect transmission, the quality of the transmitter-receiver link may be monitored to indicate when retransmissions or shifts to different links are advisable.

The host completes the process of combining transmission symbols into characters, deciphering and sending results to the terminal via a secure link.

Thus, the slashed data rate has reduced the workload of the host processor to the point where a microprocessor can do the work of a minicomputer.■■

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SND5037	Video Timer-Controller	—	CRT5037

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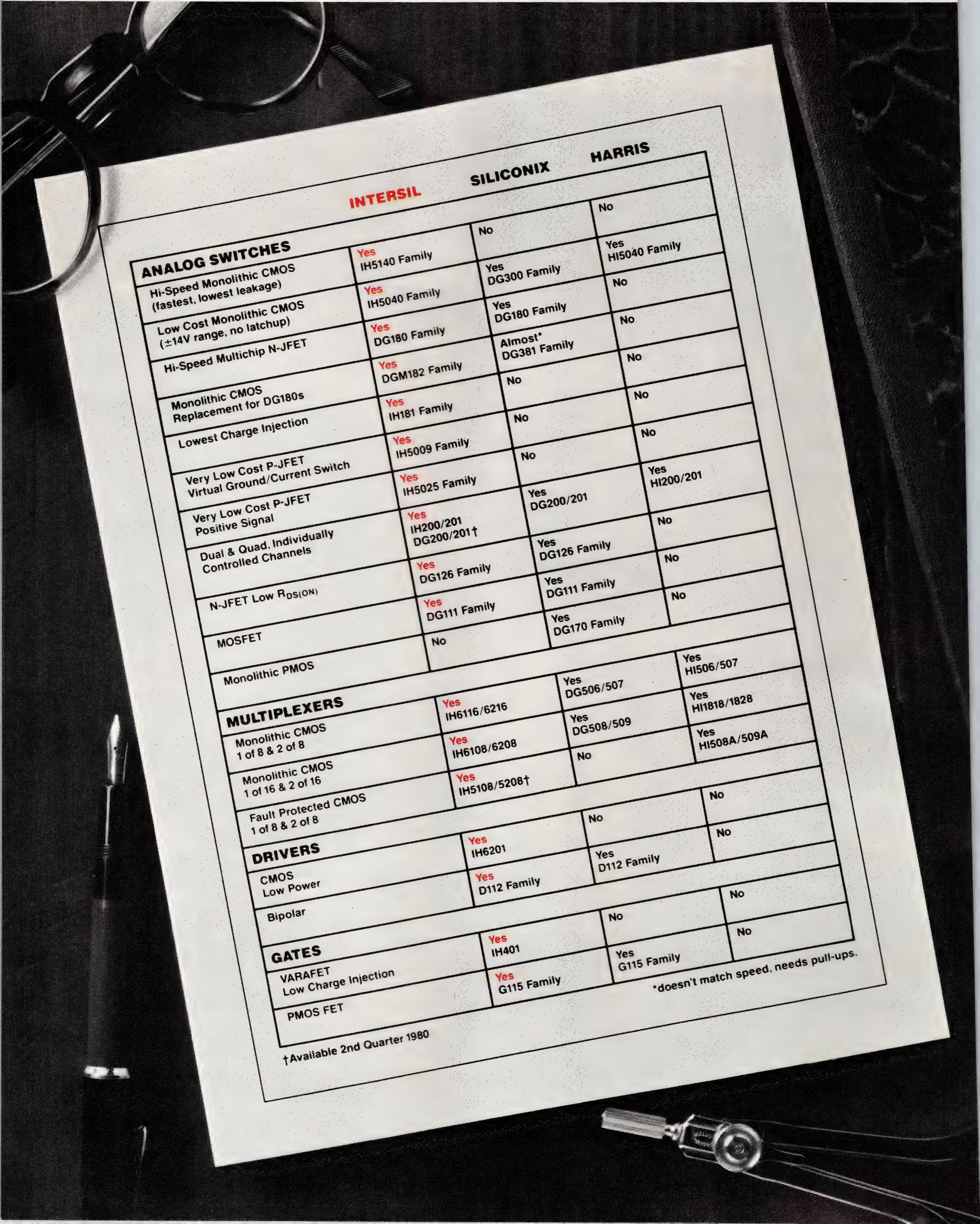
AN OPEN-BOOK QUIZ: WHO'S



	INTERSIL	SILICONIX	HARRIS
ANALOG SWITCHES			
Hi-Speed Monolithic CMOS (fastest, lowest leakage)	Yes IH5140 Family	No	No
Low Cost Monolithic CMOS (±14V range, no latchup)	Yes IH5040 Family	Yes DG300 Family	Yes HI5040 Family
Hi-Speed Multichip N-JFET	Yes DG180 Family	Yes DG180 Family	No
Monolithic CMOS Replacement for DG180s	Yes DGM182 Family	Almost* DG381 Family	No
Lowest Charge Injection	Yes IH181 Family	No	No
Very Low Cost P-JFET Virtual Ground/Current Switch	Yes IH5009 Family	No	No
Very Low Cost P-JFET Positive Signal	Yes IH5025 Family	No	No
Dual & Quad, Individually Controlled Channels	Yes IH200/201 DG200/201†	Yes DG200/201	Yes HI200/201
N-JFET Low $R_{DS(ON)}$	Yes DG126 Family	Yes DG126 Family	No
MOSFET	Yes DG111 Family	Yes DG111 Family	No
Monolithic PMOS	No	Yes DG170 Family	No
MULTIPLEXERS			
Monolithic CMOS 1 of 8 & 2 of 8	Yes IH6116/6216	Yes DG506/507	Yes HI506/507
Monolithic CMOS 1 of 16 & 2 of 16	Yes IH6108/6208	Yes DG508/509	Yes HI1818/1828
Fault Protected CMOS 1 of 8 & 2 of 8	Yes IH5108/5208†	No	Yes HI508A/509A
DRIVERS			
CMOS Low Power	Yes IH6201	No	No
Bipolar	Yes D112 Family	Yes D112 Family	No
GATES			
VARAFET Low Charge Injection	Yes IH401	No	No
PMOS FET	Yes G115 Family	Yes G115 Family	No

*doesn't match speed, needs pull-ups.

†Available 2nd Quarter 1980

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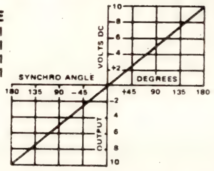
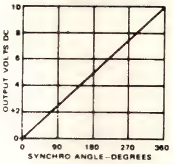
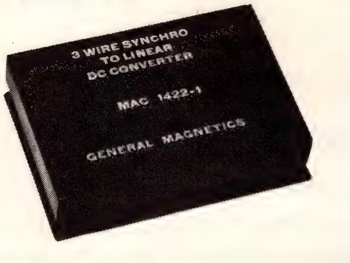
Solid State 3 Wire Synchro To Linear DC Converters...

RESPONSE CURVE
MAC 1422-1
MAC 1449-1
MAC 1458-1
MAC 1459-1



RESPONSE
CURVE
MAC 1460-1
MAC 1461-1





FEATURES:

- Develops a DC output voltage linearly proportional to a synchro angle over a ± 180° range.
- Completely solid state with all of the inherent advantages over a mechanical system such as:
  - High reliability (since there are no moving parts)
  - Light weight–6 ozs.
  - Small size
  - All units hermetically sealed
- Wide temperature range operation
- Output short circuit protected
- Three wire inputs isolated from ground
- Package size may be altered at no extra cost
- Units can be altered to accept different line to line voltages or different operating frequencies at no extra cost
- Not affected by reference voltage or power supply variations.

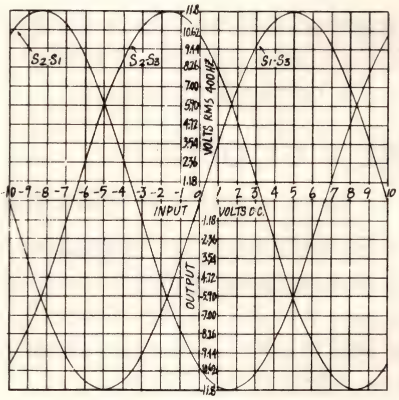
UNIT	MAC 1422-1	MAC 1449-1	MAC 1458-1	MAC 1459-1	MAC 1460-1	MAC 1461-1
TRANSFER EQUATION	± IV/18°	± IV/18°	± IV/18°	± IV/18°	+IV/36°	+IV/36°
ACCURACY (+25°C)	½%	½%	½%	½%	½%	½%
ACCURACY (–25°C-+85°C)	1%	1%	1%	1%	1%	1%
L - L SYNCHRO INPUT (VRMS)	11.8	90	11.8	90	11.8	90
FREQUENCY (Hz)	400	400	60	60	400	400
FULL SCALE OUTPUT	± 10V	± 10V	± 10V	± 10V	+10V	+10V
OUTPUT IMPEDANCE	<1Ω	<1Ω	<1Ω	<1Ω	<1Ω	<1Ω
L - L INPUT IMPEDANCE	>10K	>30K	>2K	>10K	>10K	>30K
REFERENCE VOLTAGE (VRMS)	26	115	26	115	26	115
OPERATING TEMP. °C	–25 - +85	–25 - +85	–25 - +85	–25 - +85	–25 - +85	–25 - +85
D.C. SUPPLY	± 15V	± 15V	± 15V	± 15V	± 15V	± 15V
D.C. SUPPLY CURRENT	± 75MA	± 75MA	± 75MA	± 75MA	± 75MA	± 75MA
BANDWIDTH	10Hz	10Hz	OPT.	OPT.	10Hz	10Hz
WEIGHT	6 oz.	6 oz.	6 oz.	8 oz.	6 oz.	6 oz.
SIZE	3.6x2.5x0.6	3.6x2.5x0.6	3.6x3.0x0.6	3.6x3.0x1.0	3.6x2.5x0.6	3.6x2.5x0.6

Solid State DC To Synchro Converters...

PROVIDES A THREE WIRE AC OUTPUT PROPORTIONAL TO A DC VOLTAGE INPUT

FEATURES:

- Developes a fully isolated 3-wire AC output proportional to a DC signal
- Maintains accuracy with tracking speeds as high as 720°/SEC
- Isolated reference input
- Accuracy is not affected by reference voltage or power supply variations
- Provides 0.5 VA output drive
- Three wire AC output developed with I5 minute accuracy
- Hermetically sealed metal package
- Package size and terminal configuration may be altered at no extra cost
- Units can be altered to meet your exact voltage and frequency requirements—in most cases at no extra cost
- Output remains contant for ± 10% reference voltage variations
- Low output distortion (<0.5%)
- Infinite resolution



SPECIFICATIONS: MAC 1561-1

- Input Signal – 0 to ± 10V DC
- Input Signal Resistance – 10K minimum
- Reference Input – 26 V RMS ± 10%
- Operating Frequency – 400 HZ ± 10%
- DC Power – ± 15V ± 1%
  ± 50MA no load
  ± 100 MA full load (139ΩL-L)
- Full Scale Output – 11.8V AC line to line ± 2%
- Power Output – 0.5VA max.
- Transfer Function

$$S1\text{-}S3 = 11.8V \times SIN\left(TT \times \frac{EIN}{10V}\right)$$

$$S2\text{-}S3 = 11.8V \times SIN\left(TT \times \frac{EIN}{10V} + 120^\circ\right)$$

$$S2\text{-}S1 = 11.8V \times SIN\left(TT \times \frac{EIN}{10V} + 240^\circ\right)$$

- Operating Temperature Range 0°C to 70°C
- Distortion 0.5% max.
- Accuracy*
  15 minutes of ARC (Max) at 20°C ±10°C
  30 minutes of ARC (Max) over the operating temp. range

* Accuracy is based on the following equation:

$$\theta = TAN^{-1} \sqrt{3}\frac{(1-K)}{(1+K)}$$

Where K is the measured ratio (S3-S2)/(S1-S2)

- Tracking Speed – 720°/SEC

For units to meet wider temperature range and other specifications please consult the factory.

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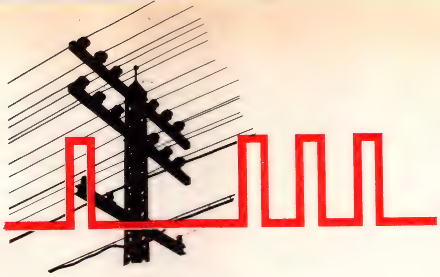
CIRCLE NUMBER 49



Optimize optical modem cost/performance through emitter, detector and fiber selection

Fiber-optic modems work across large voltage differentials, avoid ground loops, resist interference and minimize crosstalk better than copper-coax modems. Fiber-optic cable boasts a broad bandwidth (to beyond 1 GHz) and low attenuation losses. But fiber-optic modems may also cost more, and there are no "absolutes" in terms of link length or data rate that indicate when a shift from copper coax to fiber optics is justified. A systemwide comparison—feature-by-feature, cost-for-cost—must precede any substitution.

The cost/performance characteristics of fiber-optic modems improve when fibers, emitters and detectors are properly mated. Five years ago, the selection of fibers, emitters, and detectors constituted a major difficulty in the design of a fiber-optic modem. Now the optical hardware and associated electronics are well known, widely available and standardized. Prices for fiber-optical connectors have also dropped sharply, allowing fiber-optic modems to compete with coaxial cable even in applications where the unique advantages of fiber optics are less critical.

The operation of fiber-optic modems is simple: A modulated lightwave flows out of an optical transmitter, through a fiber-optic cable and into an optical receiver. Data, audio and video signals are transmitted in a noise-immune environment. The customer can plug a fiber-optic modem into an existing system and use it immediately since the input and output characteristics of the equipment will not change. Most standard off-the-shelf, fiber-optic modems are designed to be used this way. Generally, fiber-optic modems work better than coax for bandwidths exceeding 500 MHz, especially if long distances are involved.

Although glass cable is the main component of a fiber-optic modem, the associated electronics are also important. Replacing a copper cable with glass requires a redesign of the modem's electronics. The technology is new, and most users are still more comfortable with an all electronic interface than with an optical interface.

The fibers chosen for fiber-optic modems must match the intended application. Table 1 lists the characteristics of cables available from just one manufacturer. High bandwidth and low loss are associated with the more expensive fibers. Because high-quality fibers are expensive, choosing an adequate (as opposed to optimum) fiber can significantly reduce the cost of the modem.

Matching the pipe to the purpose

Table 2 lists the various Galileo modems. DL-2 is a data link, DL-A is an audio link, DL-V is a video link, DL-232 accepts RS-232 input and DL-4 is a variation of DL-232. Each modem (except DL-4) is available with every type of fiber.

As an example, for a 30-m data link, 2000 is the least expensive cable that will do the job. A 6000 cable in this application would cost much more, and its lower attenuation would not be needed. (All link distances in Table 2 are calculated so that the total specified data rates can be used.)

The modems in Table 2 are designed for the end-user market. However, a hybrid module is also available (for the OEM market) which requires more user sophistication because it is not a complete modem. This low-cost hybrid is a circuit-board compatible plug-in that requires external power and must be supplied with data in the proper format. In practice, the hybrid module becomes a front-end on a circuit board. Electronic engineers merely plug in the fiber-optic cable and wire the hybrid module to the rest of the electronics, ignoring the optics.

How signals propagate along a fiber-optic cable does not concern the user, as long as the signal received directly corresponds to the signal transmitted. If the user's output is RS-232, the transmitters of a fiber-optic modem must accept RS-232 inputs. A widely-used interconnect standard, RS-232 calls for a 25-pin connector. But rarely are all 25 pins needed; a typical application may call for only 12 to 15 pins. Therefore, the modem must be flexible enough to accept various "standard" RS-232 interconnections.

The wavelength chosen for a particular modem application represents a tradeoff between cost and distance. Low-cost light sources are useful for short-distance, medium-speed systems. However, distances in excess of 1 km or data rates above 10 MHz (or both)

Eric Randall, V.P. Engineering, Galite, Inc., division of Galileo Electro-Optics Corp., and **Ron Lavelle,** Senior Engineering Technician, Galileo Electro-Optics Corp., Galileo Park, Sturbridge, MA 01518.

require high-performance sources. The choice of source may dictate the type of fiber that can be used.

Emitter and detector considerations

The variables that affect the choice of emitters and detectors for fiber-optic modems are the same as those that affect other fiber-optic applications. Laser-diode emitters exhibit low angular divergence and high optical power and provide broad bandwidths. However, they are very sensitive to temperature. Compensating for this sensitivity in finished systems is expensive. Light emitting diodes (LEDs) provide less power but are more reliable and inexpensive. However, as data rates increase, LEDs become less effective, in part, because of their low speed-power product and wide spectral bandwidth.

LEDs are matched with specific fibers: Each fiber (Table 2) exhibits minimum attenuation over a narrow band centered on a particular wavelength. However, different LEDs have different fixturings, so just one type of diode is used with each modem in the interest of mechanical uniformity.

Similar constraints apply to detector selection. Photodiodes work well in many applications. Avalanche diodes are faster and provide a greater sensitivity, but they require a costly high-voltage supply and supporting electronics.

Table 1. Key characteristics of readily available optical fibers

Fiber (available from Galite)	Type	Attenuation range @ 900 nM (dB/KM)	Numerical aperture	Bandwidth @ 900 nM (MHz/KM)	Fiber strength (proof test in Kpsi)	Fiber diameter (μm)	Core diameter (μm)
1000	Step-index bundle	400-650	0.66	—	—	68 ±7.0	56 ±6.0
2000	Step-index bundle	200-400	0.66	—	—	68 ±7.0	56 ±6.0
3020	Step-index bundle	50-100	0.48	—	—	110 ±11	91 ±9.0
4000	Step index	8-15 (@ 820 nm)	0.40	5-15	50	204 ±10	204 ±10
5000	Step index	2-10	0.21	10-20	50	125 ±2.5	63 ±1.3
5020	Semi-graded index	3-10	0.30	10-15	50	200 ±4.0	125 ±2.5
5050	Semi-graded index	3-10	0.30	20-30	100	140 ±2.8	100 ±2.0
6000	Graded index	2-7	0.21	100-1000	100	125 ±2.5	63 ±1.3
6050	Graded index	2-7	0.21	100-1000	100	125 ±2.5	50 ±1.0
7000	Single mode	3-20 @ cutoff	0.12 nominal	>10,000 @ cutoff	25	100 ±10	7 ±3.0

Table 2. Capabilities of various data links built with continuous-length fibers

		Type of link (available from Galileo)				
	Data (DL-2)	RS-232 (DL-4)	RS-232 (DL-232)	Audio (DL-A)	Video (DL-V)	Type of fiber (see Table 1)
Length of continuous fibers (for BER $\leq 10^{-9}$ or S/N 50 dB min)	30 m	28 m	—	50 m	—	2000
	670 m	—	1700 m	—	600 m	4000
	1000 m	—	3300 m	1000 m	1300 m	5020
	750 m	—	3000 m	800 m	1000 m	5000
	1200 m	—	4500 m	1300 m	1700 m	6000
Wavelength	820 m	880 nm	790 nm	880 nm	830 nm	
LED source	RCA C30123	Zexco ZE-4301	Texas Inst TIEX-479	Zexco ZE-4301	RCA C30133	
Sensitivity	0.9 μW	0.1 μW	0.01 μW	0.04 μW	5 μW	
Data rate	DC-16 MHz	DC-50 kHz	DC-100 KHz	20-50 kHz	1-MHz	

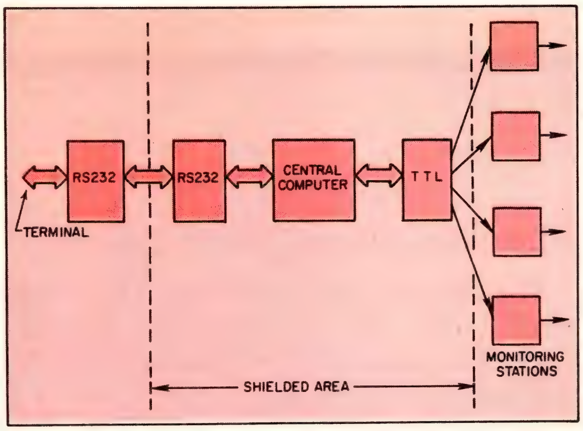
Fibers feel a reactor's pulse

The advantages of fiber optics over copper are easily demonstrated in a nuclear power plant. Modems are needed in the fail-safe monitoring system, inside the shielded area of the reactor. Design decisions for this application hinge on two parameters: life-time and reliability.

Because the reactor's fail-safe monitor system must hold up for 40 years (design life), the modems must be immune to radiation, high temperatures, humidity and mechanical stress. The modem electronics must also withstand severe vibration and meet the electrical specifications for RS-232 and TTL interfacing.

Fiber-optic modems are able to fill this bill and provide other advantages as well. Besides resisting radiation, fibers are immune to EMI, RFI and other disturbances which affect copper. The Galileo modem system guarantees an error rate of less than one error in 10^9 bits. In the nuclear plant, this modem joins forces with a Galileo radiation-hard fiber, to give excellent attenuation and bandwidth characteristics.

Information from sensors within the reactor is sent to a central computer. A fiber optic TTL modem within the reactor's shielded area then sends 20-bit parallel data from the computer over one-way lines to four external monitors (see diagram). A duplex RS-232 modem relays signals to and from the terminal, which is also outside the shielded area. To ensure reliability, a second set of TTL and RS-232 modems supplies redundancy.



The broad bandwidth of the fiber-optic modem allows the user to increase throughput quickly. In the RS-232 interface, the electronics can run at 52 kbits/s. Because fiber allows more bandwidth and less loss than copper, more throughput can be achieved at a lower cost, and the associated electronics are less complex.

The TTL portion of the fiber-optic modem replaces copper-wire modems that required 20 wires running to each monitor (one wire for each parallel bit). Each fiber-optic cable contains one fiber that can transmit up to 800 20-bit parallel words to a monitoring station every second. A copper-wire modem could never achieve this level of performance, yet would cost more and require more redundancy to exhibit an acceptable error rate.

The alignment of fiber to LED has been a problem in some modem applications. An LED output spot may measure 1 × 3 mils and must be positioned accurately in front of a fiber core. With larger fiber diameters, alignments can be less accurate; but mechanical positioning for small-core fibers must be extremely precise. The problem becomes increasingly severe with laser sources and wideband fibers. When electronics from one vendor and fibers from another are combined, these interface difficulties can complicate system diagnosis.

Modems as problem solvers

Fiber-optic modems can conquer the problems that most trouble coax links—grounding, radiation and EMI (see "Fibers Feel a Reactor's Pulse"). For example, consider a coax link between a teletype and a computer that must run beside a power line. During a power surge, the computer may pick up an error. With a fiber-optic link, however, the electromagnetic fields produced by the power line cannot induce a signal in the modem.

Fiber-optic modems can also interconnect various segments of a system with different "neutral points." Typically, sophisticated signal-processing techniques are required when a significant differential (e.g., 40 V) exists between common points. But with fiber optics, even megavolt differentials are traversed with relative ease.

Electrostatic fields from electric power plants create another environment where fiber-optic modems have many advantages. For instance, turbine brushes cause electromagnetic interference (EMI) that affects coaxial cable but not fiber-optic cable.

Fiber-optic modems can also improve telephone networks when EMI is a problem. Here, ordinary techniques for noise suppression do not work particularly well, yet fiber-optic cable can completely isolate the telephone circuit from EMI. Of course, coax cable can be shielded, but this approach is expensive; and, as more shielding is used, the available bandwidth is reduced.■■

How useful?	**Circle No.**
Immediate design application	553
Within the next year	554
Not applicable	555

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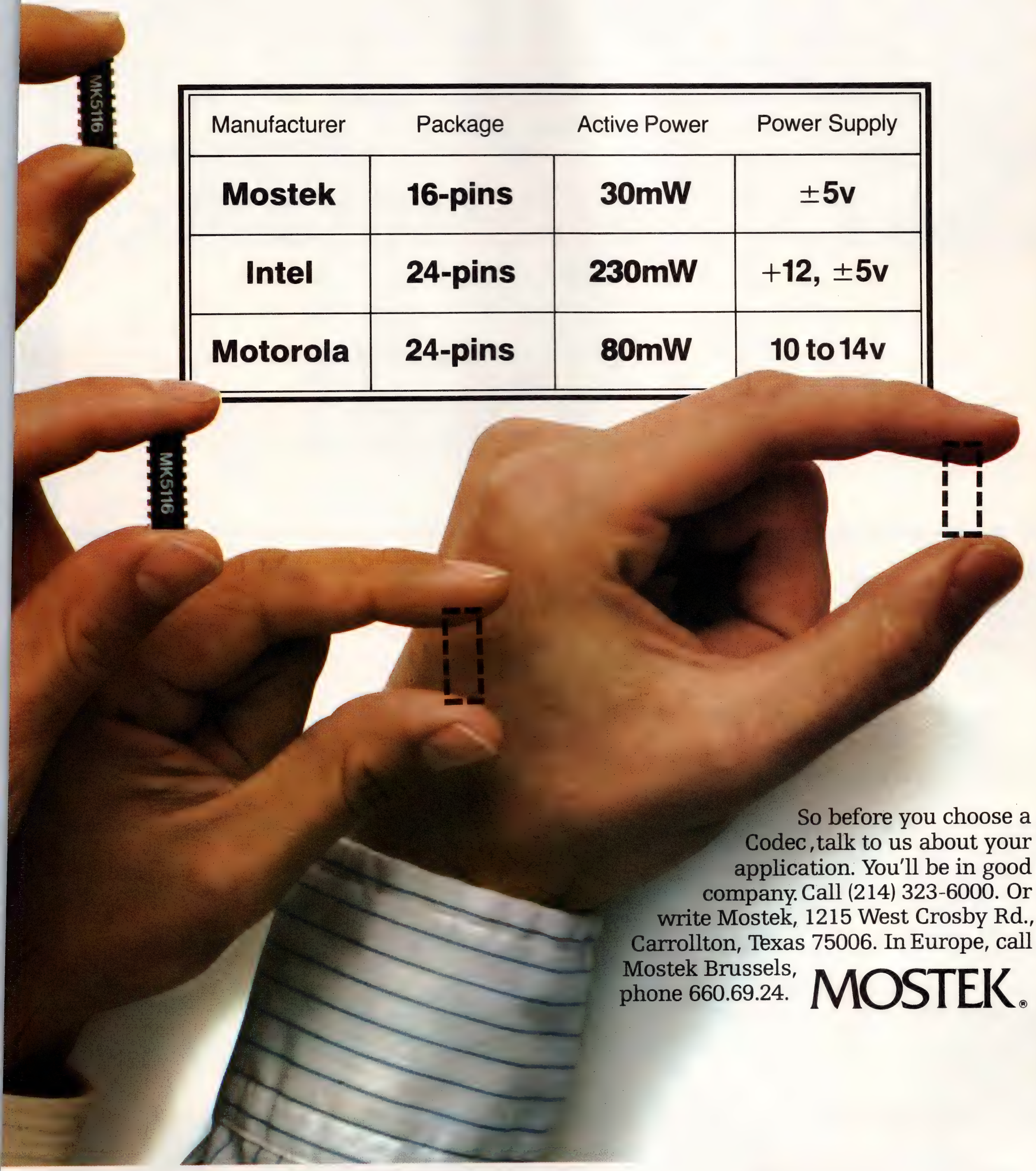
Intel	**24-pins**	**230mW**	**+12, ±5v**
Motorola	**24-pins**	**80mW**	**10 to 14v**



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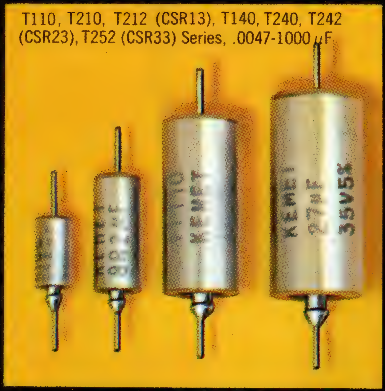
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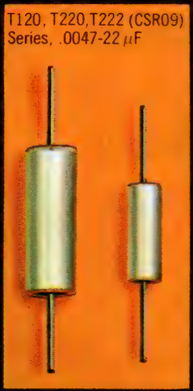
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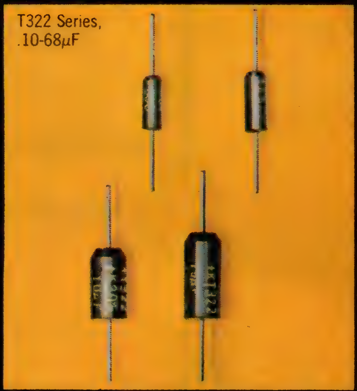
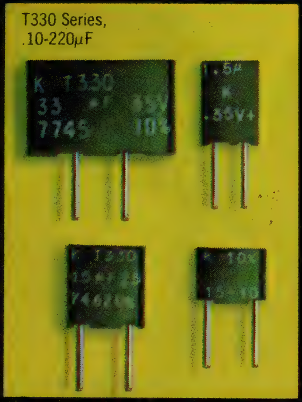
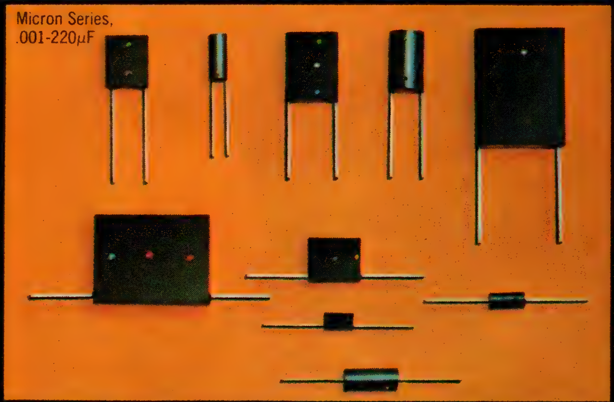
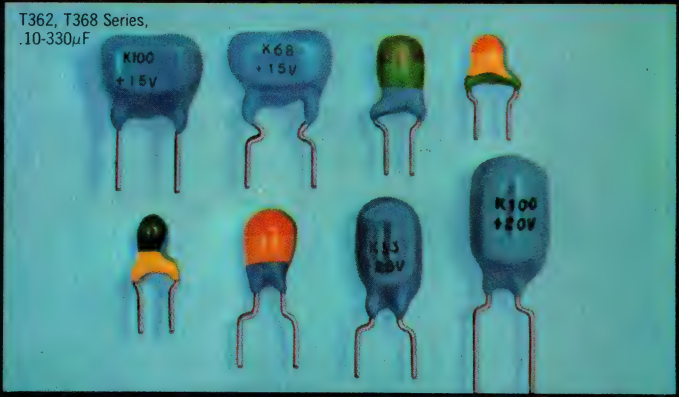
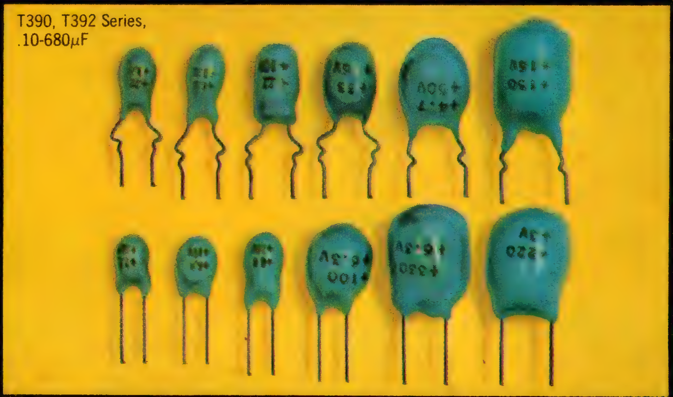

T322 Series, .10-68μF


T330 Series, .10-220μF

T411, T421 Series, .10-100μF


Micron Series, .001-220μF


T362, T368 Series, .10-330μF


T390, T392 Series, .10-680μF

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CIRCLE NUMBER 51

LEDs or DLs: Which light source shines brightest in fiber-optic telecomm systems?

The most demanding designs in modern telecomm systems are being tackled by fiber optics. This article kicks off a new series that will bring designers the tools needed to meet the challenge. Future articles will cover optical links and other telecomm areas.

Two kinds of light sources dominate in long-haul, high-quality, fiber-optic telecommunication systems: the diode laser (DL) and the high-radiance light-emitting diode (LED). In designing the optimum system, the special qualities of each light source should be considered. Diode lasers and LEDs bring to a system different:

- Power levels
- Temperature sensitivities
- Response times
- Lifetimes
- Characteristics of failure.

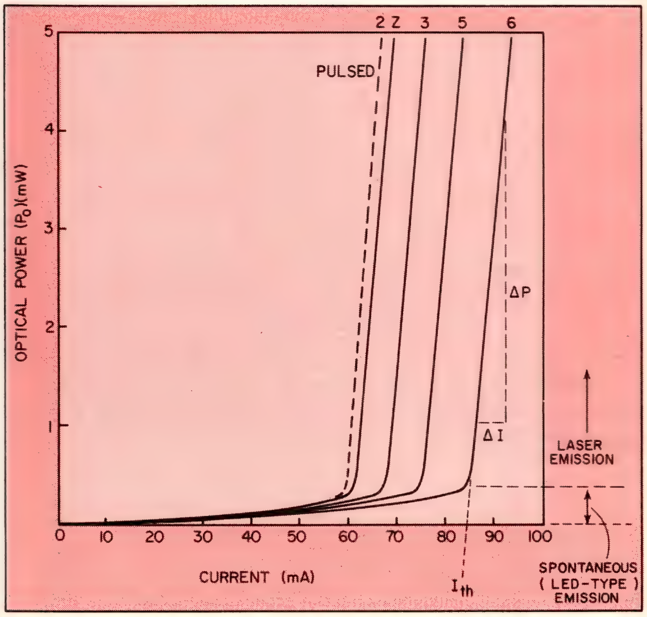
The diode laser is a preferred source for moderate-band to wideband (50 to 300-MHz) systems. It offers a fast response time (typically less than 1 ns); has a narrow optical bandwidth (as a rule less than 1 nm); and can couple high levels of useful optical power (usually several mW) into an optical fiber with a small-core and a small numerical aperture. Recent advances in epitaxial materials and device fabrication have resulted in diode lasers with extrapolated lifetimes of 10^5 to 10^6 hours at room temperature.

Some systems operate at a slower bit rate and require more modest levels of fiber-coupled optical power (50 to 250 μW). Here lies the domain of high-radiance LEDs. A LED requires less complex driving circuitry than a diode laser, needs no thermal or optical stabilization and, in general, can be produced more cheaply, with higher yields. In addition, LEDs have longer operating lives (10^6 to 10^7 hours) and fail in a more gradual and predictable fashion than diode lasers.

High-radiance LEDs and diode lasers are multilayer heteroepitaxial devices that are most frequently fabricated of AlGaAs on GaAs. Recently, much work has been done on other materials, such as InGaAsP on InP, which are suitable for generating longer wavelengths at which optical-fiber attenuation and material dispersion are lower.

Both LEDs and diode lasers behave electrically as diodes, but their light-emission properties differ substantially. A diode laser is an optical oscillator; hence, it has many typical oscillator characteristics: a threshold of oscillation; narrow emission bandwidth; a temperature coefficient of threshold and frequency, modulation nonlinearities, and regions of instability. These properties, along with the diode laser's maximum power output, efficiency and expected life, affect the design and overall performance of a laser transmitter in an optical communication link.

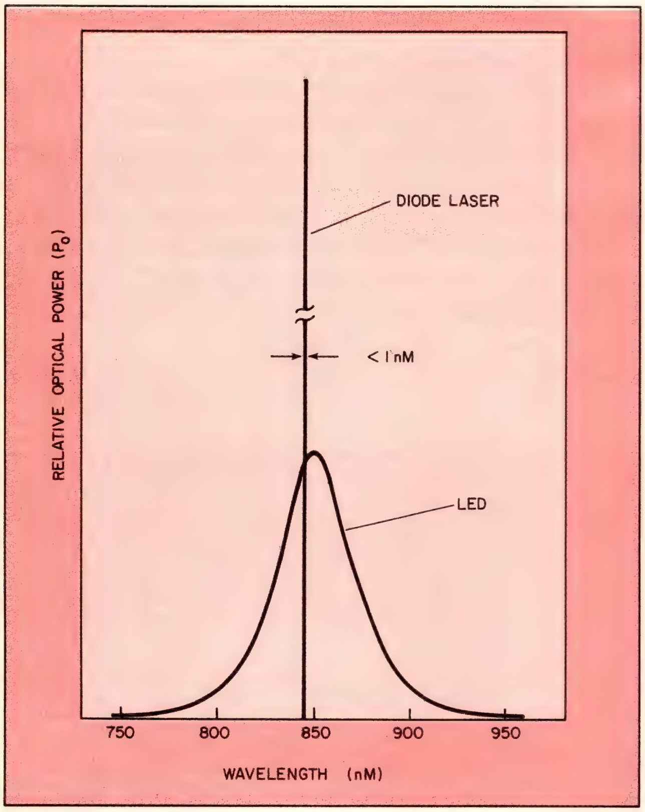
R.B. Lauer, Principal Investigator, Light Sources for Optical Communications, and **J. Schlafer,** Member of the Technical Staff, GTE Laboratories, Inc., 40 Sylvan Rd., Waltham, MA 02154.



1. Power vs current characteristics of a laser diode at different ambient temperatures show the threshold currents, I_{th}, at which oscillations begin, and their variation with temperature.

A very useful characteristic of a diode laser is the curve of output light power as a function of drive current (P_o-I). The curves (Fig. 1) for a GTE Laboratories diode laser at various heat-sink temperatures show the threshold current at which lasing (oscillation) begins (I_{th}) and the variation of the threshold current with temperature. The pulsed P_o-I curve shows that threshold current decreases with the device's temperature during pulsed operation. I_{th} is considered to be the point at which the tangent to the P_o-I curve intersects the current axis.

Below the threshold, the light output is a broadband, LED-type, spontaneous emission. Above the threshold, the lasing emission of the diode laser has the narrow bandwidth (< 1 nm) characteristic of an optical oscillator (Fig. 2).



2. Typical emission spectra for diode lasers and LEDs show the relatively narrow bandwidth of a DL above the lasing threshold.

The threshold current increases nonlinearly with temperature, T, and follows the relationship,

$$I_{th} = I_A \exp\left(\frac{T-T_A}{T_o}\right)$$

Here, I_A is the threshold current at an ambient temperature T_A (°K), and T_o is a constant for the device, called the characteristic temperature. The value of T_o is a measure of the temperature sensitivity of I_{th} and falls in the 130 to 160-K range for AlGaAs devices. Fig. 3 shows the plot of ln I_{th} vs temperature for the laser in Fig. 1.

Because of the sensitivity of I_{th} to temperature and the implied strong dependence of optical power on temperature, it is usually impractical to maintain a constant power output by controlling the laser temperature. For example, a 7°C rise in temperature above 20°C (Fig. 1) will cause the device to fall out of the lasing region, reducing the optical power from 2.0 mW to 0.4 mW. A common method for stabilizing power is to sample a portion of the emitted light and control the drive current with negative feedback. The rear-surface emission of some diode lasers can be accessed for this purpose; or a tap on the system fiber may be used.

The slope of the P_o-I curve above threshold is a measure of the electrical-to-optical conversion efficiency known as the differential quantum efficiency, η_d, and defined as:

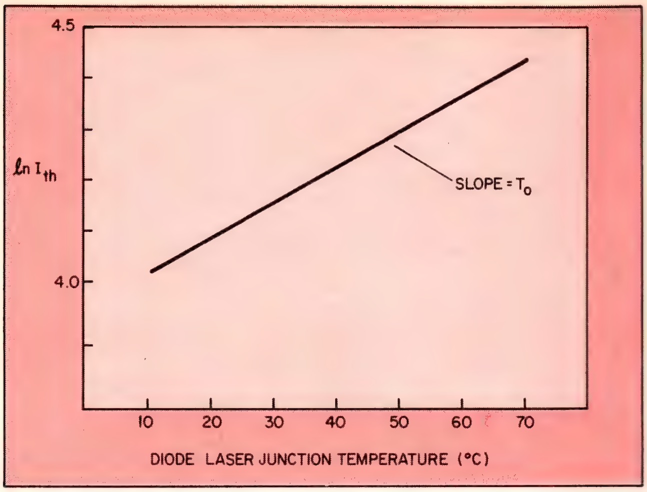
$$\eta_d = 0.806\ \frac{\Delta P_o}{\Delta I}\ \lambda \text{ (in } \mu\text{m).}$$

ΔP_o is the change in optical power from one emitting surface for a change in current, Δ I; and λ is the lasing wavelength in μm. With no coupling optics, η_d ranges from 0.10 to 0.20. When the power is measured at the output of a coupling fiber, η_d includes the laser-to-fiber coupling efficiency. For communication applications, diode lasers coupled to a short-fiber fly-lead are usually prudent choices. Even with good equipment, optimum coupling can be elusive and is better left to the diode laser manufacturer.

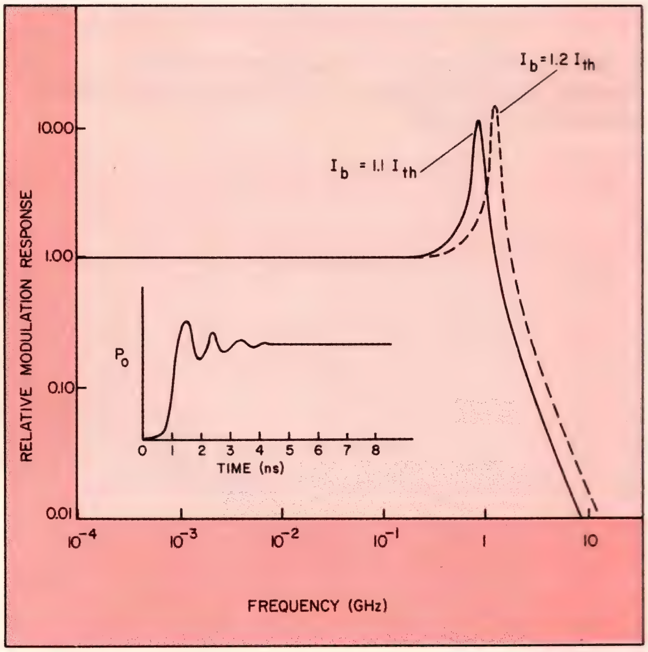
Biasing a DL helps in digital systems

Most transmitter designs operate the laser with the modulation signal superimposed on a bias current set at or above I_{th}—a requirement for linear operation in an analog system. The biasing has some advantages in digital systems as well. With a constant bias, the laser junction temperature does not fluctuate as widely as it would if the lower level of the digital signal were zero current. Hence, constant bias reduces variations in the signal-induced output power.

In digital operation, biasing also eliminates laser turn-on delay. Turn-on delay is the lag between the application of a current step and the start of laser emission; it is the time required for the gain to build up to the oscillation threshold in the laser cavity. A step from zero current to 10% above I_{th} can cause a delay of 4 to 8 ns, which is too long for systems with



3. The temperature dependence of its threshold current complicates the operation of a diode laser.



4. The frequency responses of a diode laser at different bias currents and its time response show the effect of relaxation oscillations.

Optical power coupled into various lengths of step-index fibers

	Launch		Equilibrium	
Fiber	**P°_{100}(μW)**	**NA_{2m}**	**NA_{eq}**	**$P^\circ_{100}\left(\frac{NA_{eq}}{NA_{2m}}\right)^2$($\mu$W)**
Corning FAT	250	0.30	0.28	218
Galite 3000LC	1000	0.60	0.24	160
Quartz & silica	350	0.35	0.20	114
Maxlite	450	0.40	0.26	190

fast data rates. Biasing a laser just above its threshold eliminates the turn-on delay.

However, operation with a bias level near threshold may present problems in digital systems which require a high contrast (on-to-off) ratio, especially if the laser has a high level of spontaneous emission at its threshold. Spontaneous emission determines the light level in the off state.

The frequency response of diode lasers biased above the threshold typically extends beyond 1 GHz. Some devices exhibit a peaked response at their cutoff frequency, with the peak moving toward higher frequencies as bias current increases (Fig. 4). This peaked characteristic leads to a damped ringing or relaxation oscillation in response to a step input. Often, the ringing frequency will be well above the system's bandwidth and so will not compromise its performance. Applications that use extremely wide bandwidths may require lasers that are free of relaxation oscillations.

Nonlinearities in the diode laser power-current relationship—an important consideration for analog applications—may be both subtle and gross. Large distortions appear as "kinks" in the P_o-I curve. These kinks are usually associated with an instability in the laser mode-guiding mechanism and appear as a region of reduced quantum efficiency and increased noise output. Small nonlinearities, on the other hand, require harmonic or intermodulation analysis. One or more sinusoidal modulation signals are applied to a laser prebiased above threshold. The detected light is analyzed for the strength of the distortion products. For good linearity and low noise, kinks in the P_o-I curve should be well above the peak-power levels at which the laser will be used.

While the maximum power output specified for many diode lasers is quite high (tens of mW), the devices should operate at much lower levels of power. As with any semiconductor device, operation at the maximum rating reduces lifetime. The c-w operating power should be the value that the manufacturer specifies for good reliability. With pulsed operation, peak powers may go somewhat higher, depending on the duty factor, although the relationship between peak power and laser degradation is still vague.

The output-wavelength spread, or spectrum, of diode lasers is much narrower than that of LEDs: about 1 nm compared with about 40 nm for a LED (Fig. 2). Narrow spectra are advantageous in systems with high bit rates: If broad-spectrum LED sources are used, the material dispersion of the fiber (variations of propagation velocity with wavelength) can broaden the pulse excessively over km distances.

The diode-laser spectrum in Fig. 5 is composed of a set of wavelengths, or modes, spaced 0.25 to 0.30 nm apart. Ten or more modes, each with significant power, can be present at the threshold. But this number usually drops to only a few modes above the threshold. Some lasers develop more than 90% of their output power in a single mode for drive currents 10%

beyond the threshold value, I_{th}.

These lasers are specified as single-mode devices. This description refers to the spectrum for dc-drive conditions. However, when single-mode lasers turn on, they are frequently in a multimode condition. Unless they are biased well above the threshold, they may take tens of ns to settle into a single mode.

The choice between a single-mode or multimode laser may be academic unless fiber and modal-noise problems become bothersome.[2] The noise occurs when the propagating modes of the fiber waveguide interfere with each other at a discontinuity, such as a fiber tap, splice or connector. Imperfections at an interface may spatially filter portions of the interference patterns, so that the transmitted power becomes a function of the intensity distribution of the pattern. Changes in fiber orientation, temperature, or laser frequency can shift the intensity distribution, causing random variations in transmitted power.

Because of its high coherence, a single-mode laser forms a very distinct interference pattern, aggravating this condition. However, in a multimode laser, each of the multiple frequencies present forms its own pattern, so intensity variations tend to average out, suppressing fiber modal-noise.

LEDs may have a deceiving output

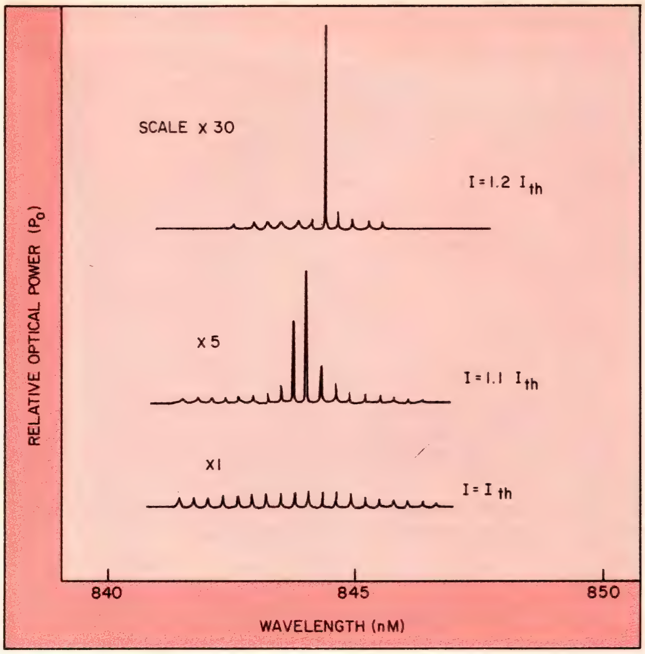
Where the diode laser's power, speed, or spectral width are not essential, LEDs can offer system designers better temperature stability and reliability at lower cost.

Fig. 6 shows typical curves for power vs current at various ambient temperatures for a fiber-coupled, high-radiance LED. In this case, a GTE Laboratories' LED has been coupled into a Corning grade-index optical fiber (NA is 0.22; core-diameter is 62 m), and the optical power is measured emerging from a 2-m fly-lead. The optical output of the LED (unlike that of the diode laser) is relatively insensitive to temperature, varying only 0.3% per °C.

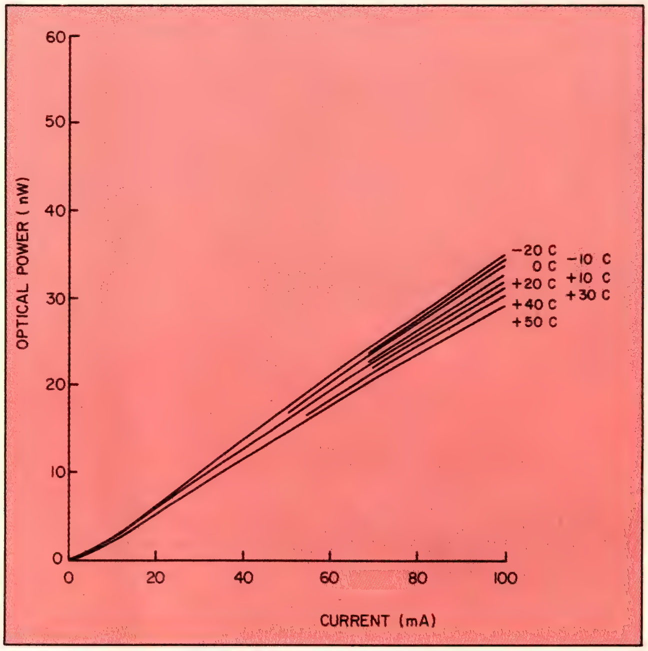
However, the measured power output of fiber-coupled LEDs is not always the output delivered. The LED module that appears to have the least fiber-coupled power may actually have the highest optical power at equilibrium.

When the LED fly-lead fiber is coupled to a system fiber with a nominally identical numerical aperture (NA) and core diameter, unexpected losses may result above and beyond those intrinsic in the splice or connector. Characteristically, a fraction of the power launched into fibers from a LED or other broad-area source goes into nonpropagating fiber modes in the core. Fig. 7 shows that the power in these modes is lost within a few tens of meters.

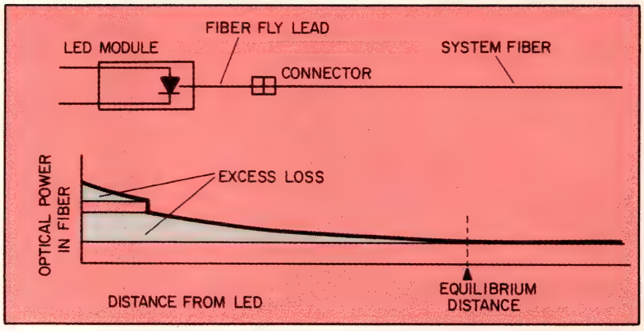
Some of the power measured from a LED with a short fiber fly-lead will not be coupled into the equilibrium propagating modes of the system fiber and will appear as an excess loss. Fiber-coupled lasers are less prone to this effect because they tend to excite



5. The emission spectra of diode lasers narrow dramatically with increasing current above threshold, in an expansion of Fig. 2.



6. For a fiber-coupled LED, power vs current characteristics vary with ambient temperature, but not as drastically as for a diode laser.



7. Optical power in the fiber drops with distance from the LED source, at a rate greater than the nominal, up to the equilibrium distance.

fewer nonpropagating modes, especially if the laser-to-fiber coupling is through a lens.

These nonpropagating modes account for the relatively low equilibrium power of some fibers in response to high launched powers. The table illustrates how surprising the results of this effect can be. The optical power that can be coupled into 2-m lengths of the indicated step-index, large-core, optical fibers (from a standard high-radiance LED) essentially equals $P°_{100}$—the optical power in μW emerging from the 2-m fly-lead in response to 100 mA of LED drive.

Superficially, the powers more or less scale with $(NA)^2$, as would be expected. Furthermore, the LED module using the Galite 3000LC fiber looks like the preferred choice for any system application. But, when the power is calculated after the launched modes have come to equilibrium, an entirely different result emerges, as the last column of the table shows. The optical power scales as the ratio of the squares of the NAs. Therefore, $P°_{100}$ is normalized to equilibrium by multiplying it by the square of the equilibrium-NA to launch-NA ratio $(NA_{eq}/NA_{2m})^2$. Most optical fibers in telecommunications reach 80-90% of their equilibrium NA after approximately 50 m; hence, that value of optical power is the most important one for the designer of LED-based optical-fiber telecomm systems.

In systems with a high data rate, the asymmetric transient response of a high-radiance LED (different rise and fall times) can be a problem. The fall time depends on the recombination time of injected carriers. It is usually exponential, with a 1/e time constant of 5 to 15 ns. The rise time is a function of the peak drive current, I_d, and the device's space-charge capacitance, C_s. If the 1/e fall-time constant (T_F) is known, then the 10 to 90% rise time, τ_R, can be predicted from:

$$\tau_R = T_F + 1.39 \frac{C_s}{I_d} \frac{(pF)}{(mA)}$$

The capacitance C_s is measured at zero bias. Rise and fall times can usually be halved by using current-peaking in the drive circuit.

For fiber-optical systems which have medium bandwidths (≃40 Mbits/s) and use LEDs, fiber-material dispersion is a more likely limitation on transmission distance than either the LED bandwidth or the fiber attenuation. Long-distance transmission requires a narrow-spectrum light source, such as a diode laser.

Temperature affects the MTBF

For both AlGaAs/GaAs-based diode lasers and LEDs, the mean time before device failure (MTBF), varies exponentially with temperature:[3]

$$\tau_{T_o} = \tau_{T_j} \exp \frac{E_A}{k} \left(\frac{T_j - T_o}{T_j T_o} \right)$$

For both types of diodes, T_j is the junction temperrature in °K during operation; T_o is a reference temperature (e.g., room temperature) in °K and is less than T_j; π_{T_j} is the MTBF at T_j; π_{T_o} is the extrapolated MTBF at T_j; and k is Boltzmann's constant in eV/°K. The activation energy for the degradation process, E_A, is 0.85±0.15 eV for diode lasers[4] and 0.5±0.1 eV for LEDs[5]. The time-temperature relationship provides a basis for accelerated life testing and prorating of diode lasers or LEDs. For example, at a junction temperature of 65 C, corresponding to a case temperature of 55 to 60 C, in a device with good heat sinking, diode lasers degrade five times faster than LEDs.

Diode lasers from GTE Laboratories have operated in the lasing region at junction temperatures of 70°C for more than 12,000 hours before failure. GTE's LEDs have operated more than 14,000 hours at a junction temperature of 150 C and a current density (j_D) of 4.0 kA/cm². The corresponding extrapolated lifetimes of these devices at 25 C are: 9.3×10^5 for the laser diode and 4.5×10^6 for the LEDs. Failure for the lasers is defined as the inability to obtain 1 mW of lasing optical power per facet for any drive current. Failure for the LEDs is defined as the point at which the initial optical power is reduced by 3 dB.

This treatment of device reliability has not examined explicitly the effect of current density on device life. However, current density must affect lifetimes—especially of diode lasers—since the threshold current, and hence the operating current density, increase with increasing junction temperature. In spite of a lack of adequate experimental results, the effect of current density is generally believed to be small compared to the effects of temperature; device degradation is roughly proportional to $(j_D)^n$ where n lies between 0.5 and unity. In addition, all reported reliability studies on diode lasers and LEDs have employed dc bias; but no reliability studies for these devices have been reported for pulsed operation—the situation existing in a systems application. While suspicion is strong that degradation, at least to the first order, should be proportional to the average power, no experimental verification exists.■■

References

1. Arnold, G., and Russer, P., "Modulation Behaviour of Semiconductor Injection Lasers," *Applied Physics*, 14 (1977), p. 255.

2. Epworth, R.E., "The Phenomenon of Modal Noise in Fiber Systems," IEEE Topical Meeting on Optical Fiber Communications, May 6-8, 1979, Paper ThD1.

3. Hartman, R.L., and Dixon, R.W., "Reliability of DH GaAs Lasers at Elevated Temperatures," *Appl. Phys. Lett.*, 26 (1979), p. 239.

4. Ettenberg, M., "A Statistical Study of the Reliability of Oxide-defined Stripe c-w Lasers of (AlGa) AS," *J. Appl. Phys.*, 50 (1979), p. 1195.

5. Yamakoshi, Shigenobu; Hasegawa, Osamu; Hamaguchi, Hisashi; Abe, Masayoki; and Yamaoka, Toyoshi, "Degradation of High-Radiance Ga_{1-x} AlAs LEDs," *Appl. Phys. Lett.*, 31 (1977), p. 627.

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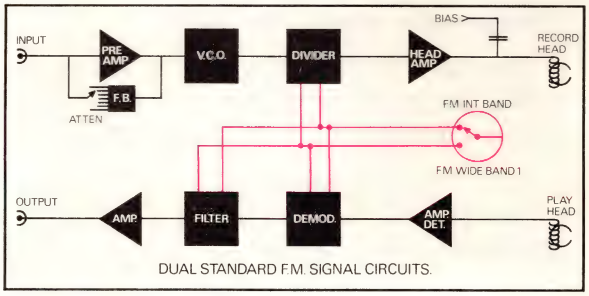

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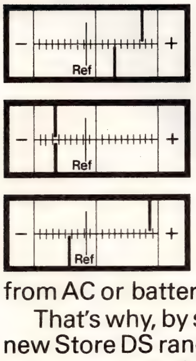

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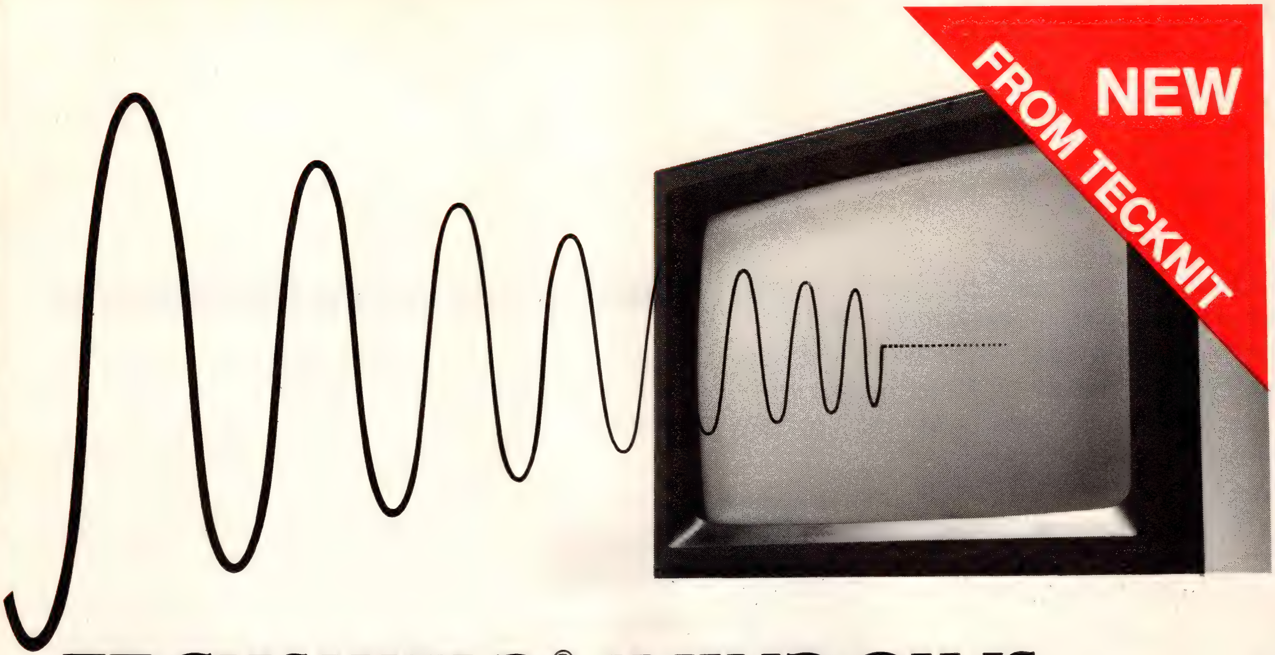

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All-CMOS components build a μC system that checks power loss, eases regulation

By building a microcomputer system from all-CMOS components, designers can reduce power dissipation, simplify regulation and increase noise immunity. The use of the NSC800 family, fabricated with a high-performance version of CMOS (see "P²CMOS—A Major Advance in CMOS Density"), demonstrates how these advantages accrue in a remote data-acquisition system.

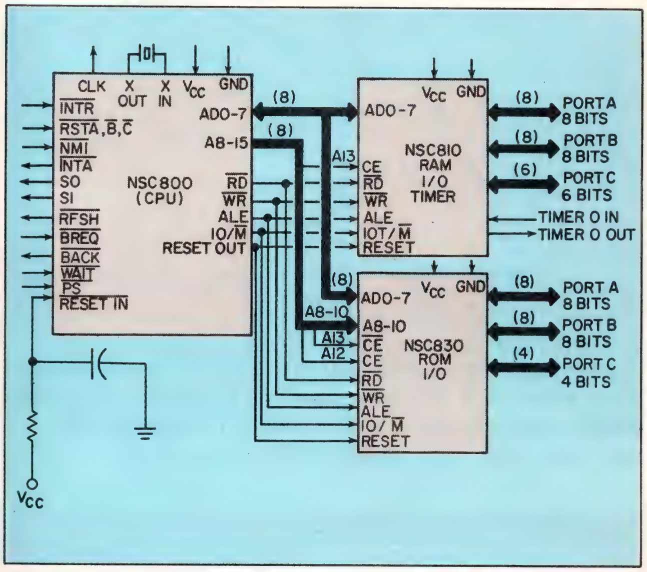
At the device level, reduced power dissipation means that, at a given ambient temperature, the junction temperature of the CMOS circuit (in, for example, a ceramic package) will be about 20 C lower than that of a NMOS circuit. The lower junction temperature could reduce the system's failure rate by a factor of 10 to 100.

At the subsystem level, the low power dissipation means that less costly packaging can be used where the external environment permits. The increased packing density and the reduced power requirements add up to a reduced power-supply capacity (or even battery operation), simpler regulation and reduced venting (since the system eliminates less heat). In some applications, hermetic packaging would be possible for the first time, giving additional protection in hostile environments.

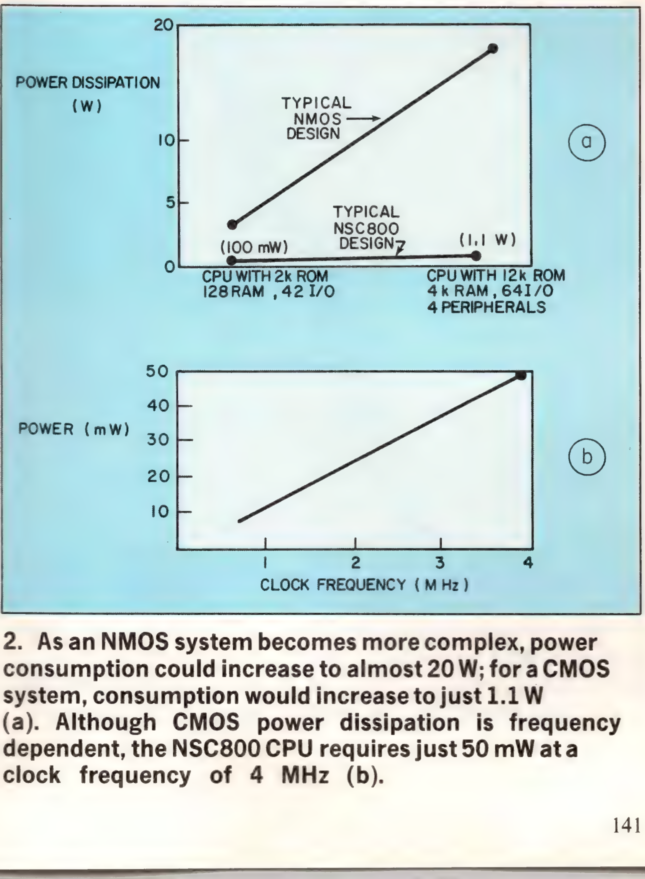
NSC800 family cuts power dissipation

The NSC800 microprocessor operates at 4-MHz clock rates while dissipating less than 5% of the power used by previous NMOS chips. With an architecture that resembles the Z80's and a bus structure that resembles the 8085's, the NSC800 improves upon their features, yet is software compatible with both processors (see "A Look at the NSC800 Family"). It can be used in many applications—especially remote data acquisition—where power is at a premium.

In large-systems using dynamic memories, the built-in refresh capability of the NSC800 CPU provides an 8-bit refresh address—one bit larger than that provided by the Z80. This extra bit makes the CPU compatible with 64-kbit dynamic RAMs and

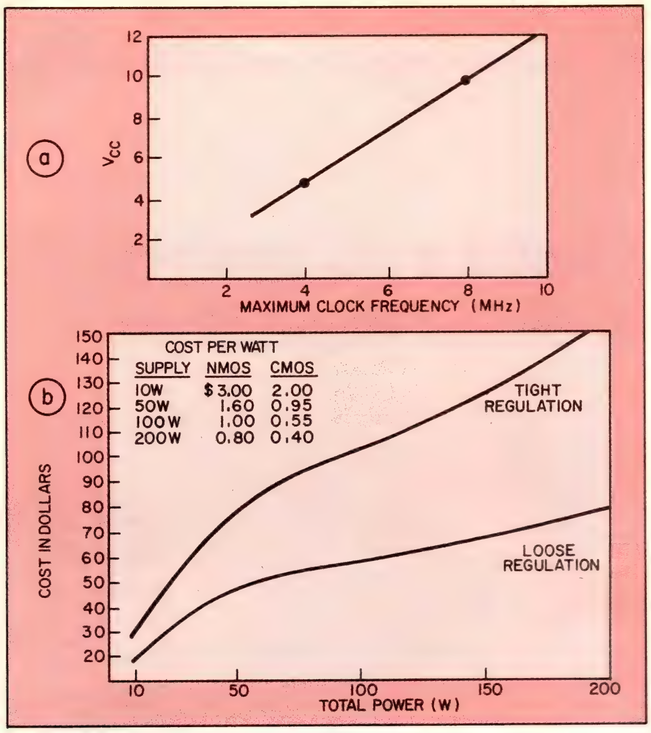


1. Three P²CMOS chips, the NSC800, 810 and 830, make a complete microprocessor system with CPU, RAM, ROM, counter/timers, 42 I/O lines and a large address space of 64 kbytes.

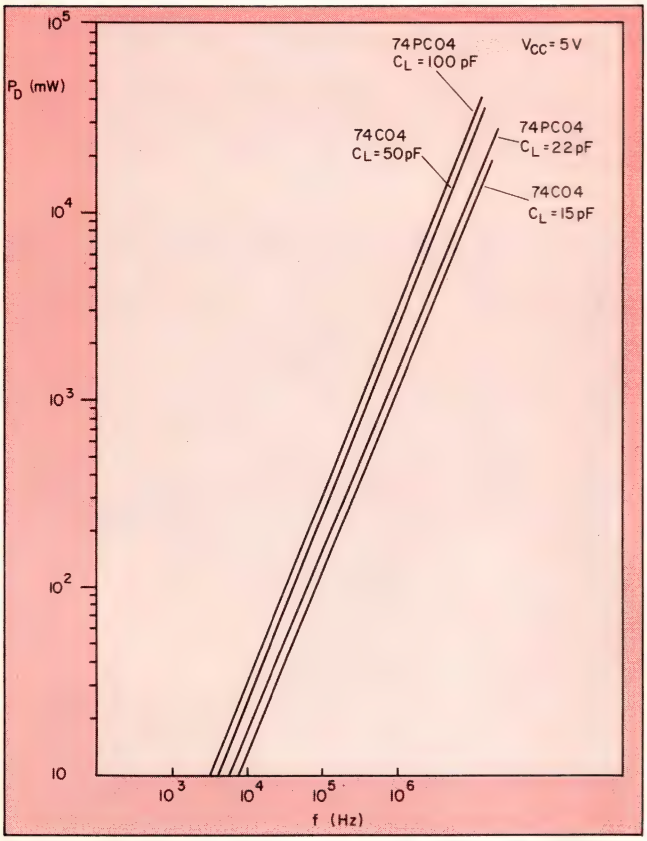


2. As an NMOS system becomes more complex, power consumption could increase to almost 20 W; for a CMOS system, consumption would increase to just 1.1 W (a). Although CMOS power dissipation is frequency dependent, the NSC800 CPU requires just 50 mW at a clock frequency of 4 MHz (b).

Keith Winter, Applications Engineer, and **Anne Wagner-Korne,** Product Marketing Manager, National Semiconductor, 2900 Semiconductor Dr., Santa Clara, CA 95051.



3. CMOS operates over a wide voltage range, and higher clock frequencies can be used if the operating voltage level rises above 5 V (a). Because CMOS devices draw little power, supplies require a lower power rating; thus, the cost per watt can come down (b).



4. With the introduction of SSI and MSI circuits fabricated in the P²CMOS technology, speed-power products show a marked improvement, especially with heavier capacitive loads, compared to the equivalent 74CXX logic devices.

gives simple refresh support to very large memory systems.

The CPU takes advantage of two P²CMOS LSI support circuits (the NSC810 and NSC830), a new family of high-performance SSI and MSI P²CMOS circuits, and all-standard, off-the-shelf CMOS logic circuits (see Table 1). The NSC810 combination RAM-I/O-timer provides 128 bytes of RAM, individually programmable I/O lines and two prescaled 16-bit counter/timers. The NSC830 provides 2048 bytes of ROM, as well as programmable I/O lines. The resulting three-chip system (the NSC800, 810 and 830) delivers 42 inputs or outputs, five interrupt inputs, two counter/timers, an integral clock generator, RAM, ROM and memory-refresh capability (Fig. 1).

The three circuits operate over a wide voltage range (3 to 12 V) and an extensive temperature span (−40 to +85 C), with a typical power dissipation of less than 100 mW for all three (Fig. 2a). Power dissipation drops in proportion to the clock frequency (Fig. 2b).

Because the NSC800 family operates over a wide voltage range, power-supply options can be tailored to a particular application (Fig. 3a). The degree of regulation needed—and the cost of the supply—can be greatly reduced in many cases (Fig. 3b).

CMOS also offers a typically higher noise immunity. For the NSC800, the margins are specified at 30% of the operating voltage level. This again reduces design considerations and makes operation feasible in electrically "dirty" environments.

In remote data-acquisition systems, the NSC800 family is supported by SSI and MSI logic circuits, as well as CMOS real-time clocks and a/d converters (or complete CMOS front-ends).

To meet some of the logic support requirements, National Semiconductor will offer the 74PCXX family of SSI and MSI support circuits. Like the 74C family of CMOS logic replacements for TTL devices, the 74PC is fabricated from P²CMOS to create the high-performance "glue" circuits required by most applications.

Initially, nine 74PC and 82PC circuits will be available; however, additional circuits will be introduced at a later time. These circuits perform better than the older 74C family. For example, the 74PC00, 02, 04, 08 and 32 will offer operating voltage ranges of 3 to 12 V, a 100-pF drive capability and propagation delays of just 18 ns (10-V supply and 15-pF load). As with all CMOS circuits, power dissipation depends on the input frequency; the curve in Fig. 4 shows the typical power dissipation of one of the gates.

More complex functions (such as the MM74PC74 dual D flip-flop or the 74PC138 decoder) offer similar improvements. The flip-flop has a propagation delay from the clock of just 40 ns (at 5 V), and the decoder introduces a delay of just 32 ns, maximum, with a 100-pF load. Additional support circuits include the 82PC08 and 82PC12, which are P²CMOS equivalents to the NMOS 8208 and 8212 circuits.

An all-CMOS remote data-acquisition system (Fig.

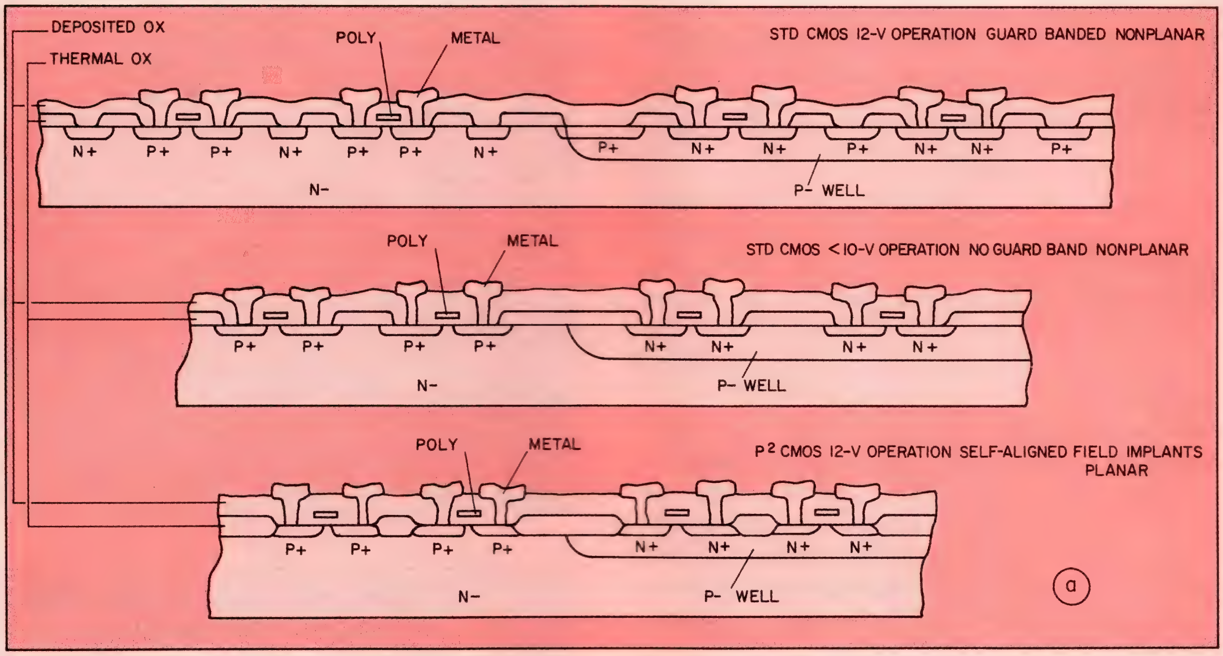
P²CMOS—A major advance in CMOS density

To provide the density for fabricating a high-end 8-bit microprocessor on a single chip, the P²CMOS process uses silicon-gate technology. It gives a favorable tradeoff between performance, reliability, power dissipation and manufacturability. P-type wells, selective field oxidation and self-aligned ion implants optimize device topology, for a 50% reduction of the linear chip area between cells. This thinner separation and a 30% device scaling greatly improve the speed-power product.

The denser layout reflects the use of field surface doping to extend the operating voltage range; the usual CMOS guard rings are not needed (see Fig. A). A doped layer of polysilicon over a sub-1000 Å oxide forms the self-aligned gates. A second layer of polysilicon provides the interconnect, improving the flexibility of the design and the layout density. These features combine with carefully controlled source-drain diffusions and special metallizations to produce such devices as the NSC800 family.

The P²CMOS process does have its penalties—it requires about 20 to 25% more masking steps, though most of the additional steps are not critical. One advantage, the bipolar transistors that are inherent in most CMOS processes (Fig. B), is limited because the bipolar devices can only be used in emitter-follower configurations (with the collector common to the V_{CC} line). However, the transistors can provide high-current drive for a relatively small chip area.

Thus, the P²CMOS process brings advances not only in processing, but also in fabrication techniques—ion implantation, dry plasma etching, noncontact printing and E-beam generated masks. An evolutionary product, rather than revolutionary, the NSC800 family benefits from the reliability and manufacturability guidelines and precedents set in earlier processes.


DEPOSITED OX
THERMAL OX
POLY
METAL
STD CMOS 12-V OPERATION GUARD BANDED NONPLANAR
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P+
P+
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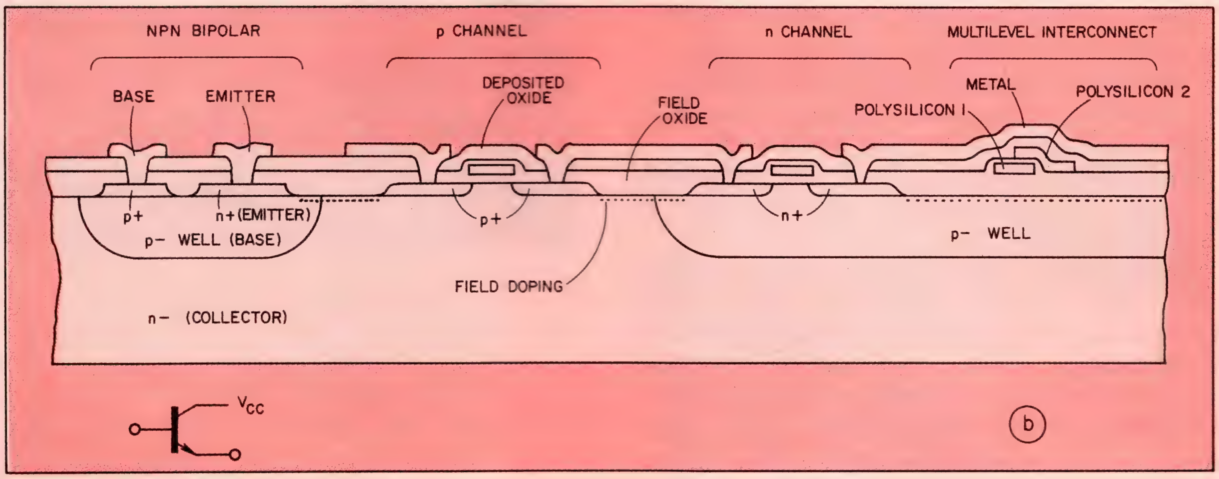


5) can withstand harsh environments, draws very little power, is very compact and is easy to configure. All major components—five LSI circuits plus a few SSI devices—require just 125 mW during operation, and even less in the standby mode, permitting operation from a 5-V rechargeable battery pack. The host supplies the high current needed by the current-loop serial interface.

The system contains an NSC800 CPU, an 810 RAM-I/O-timer, an 830 ROM-I/O circuit, an ADC0816 16-channel 8-bit a/d converter (ADC), and an MM58167 real-time clock (RTC). Two lines of the 830 form a serial port communication link so that the remote system can transfer data to a host system. The RAM of the 810 serves as a data buffer to store intermediate measurements, and as a scratchpad for calculations. Both timers on the 810 count down the crystal frequency and produce the clocks required by the ADC and RTC. The power-down capability of the CPU helps reduce the system's power consumption to just 70 mW when data acquisition is not necessary.

One of the analog input channels of the ADC connects to a battery pack. Because it would have to operate even if a power failure occurred, the remote data-acquisition system must have battery operation or at least a battery backup. The CPU monitors its own supply voltage and notifies the host system when a battery change is needed.

In the NSC800-based system, the ADC0816 takes readings on various input conditions. The types of input devices connected to the ADC depend on the parameters to be measured. For example, the inputs to the converter could be from temperature sensors, fluid flow sensors, level sensors or other types of transducers.

System programming determines when the ADC will sample an input channel, perform a conversion and send the data to the RAM. The readings are checked, if necessary, against set points, and a warning is transmitted if the set points are exceeded. The host system does not have to command the ADC to take readings every time they are necessary. Instead, the processor sets up the RTC to interrupt it at a predefined time to receive data from the ADC.

The reading values taken by the converter can be transferred to the NSC810 for later processing or correlation. For example, if temperature transducers are used to monitor a building, it might be desirable to know the high and low temperatures during a 12-hour period. After compiling the information, the system could dump the data to the host over a communications link.

The required clock signals for the ADC and RTC peripherals are generated by the two timers in the 810. With various divisors, the master clock generated by the NSC800 is counted down to produce the frequencies needed for the RTC (timer 1) and the ADC (timer 0). Table 2 shows four crystal frequencies that are readily available, and the results of various divide ratios.

Table 1. CMOS logic and support circuits

Model number	Description
Memories	
MM74C920/1	256 x 4 RAM
MM74C929/30	1 k x 1 RAM
NMC6503*	512 x 4 RAM
NMC6513*	2 k x 1 RAM
NMC6504*	1 k x 4 RAM
NMC6514*	4 k x 1 RAM
Peripheral controllers	
MM58167	Real-time clock (8-bit bus)
MM58174	Real-time clock (4-bit bus)
MM74C922/3	Keyboard encoders
MM74C911/12/17	Display controllers
MM5452	LCD display driver
Analog interfaces	
ADC3511	3.5-digit integrating a/d
ADC3711	3.75-digit integrating a/d
ADC0816	16-channel, 8-bit ADC
ADC0808	8-channel, 8-bit ADC
ADC1210	12-bit ADC
DAC1020	4-quad multiplying DAC
DAC1220	4-quad multiplying DAC
DAC1001-1008	10-bit d/a (Micro-DAC)
ADC0801-0804	8-bit a/d (Naked-8)
Auxiliary components	
MM74PC00*	Quad NAND gate
MM74PC02*	Quad NOR gate
MM74PC04*	Hex inverter
MM74PC08*	Quad AND gate
MM74PC32*	Quad OR gate
MM74PC74*	Dual D flip-flop
MM74PC138*	1-of-8 decoder
MM74C42	1-of-10 decoder
MM74C240	Octal buffer
MM74C373/4	Octal latch
MM74C908	Dual relay driver
MM82PC08*	Octal driver
MM82PC12*	8-bit I/O port
MM88C30	Dual differential driver

Table 2. Clock frequencies available to NSC800

Crystal frequency	CPU clock output	Timer 0 output	Timer 1 output
2.097152 MHz	1.048576 MHz	262.144 kHz divisor = 4	32.768 kHz divisor = 8
3.276800 MHz	1.638400 MHz	327.680 kHz divisor = 5	32.768 kHz divisor = 10
4.194304 MHz	2.097152 MHz	262.144 kHz divisor = 8	32.768 kHz divisor = 8
4.915200 MHz	2.457600 MHz	491.520 kHz divisor = 5	32.768 kHz divisor = 15

The RTC function of the MM58167 lets the system program its interrupt register either for a time-of-day match (which includes the day of the week, the date and month) or for every month, week, day, hour, minute, second or tenth of a second or for both schedules. The data format of the RTC is binary-coded decimal. Thus, precise time-of-day measurements can be made without the CPU doing the time-keeping.

The interrupt output of the RTC can be connected through one port bit of the NSC810 to put the CPU into its power-save mode and reenable it at a preset time. This interrupt output can also connect to one of the hardware restart inputs (RSTB), for measuring time-duration. However, without the RTC, the CPU would have to do the timekeeping and thus could not go into the power-save mode.

The CPU communicates with the peripheral devices through the I/O ports of the NSC810 and NSC830, since the peripherals are not directly compatible with the multiplexed bus structure of the NSC800. For example, data that must be written into the RTC are first output to Port A. Then, the address of the internal register is selected and the chip-select signal is applied via Port B. A bit-set-and-clear operation emulates a pulse on the bit of Port B which is connected to the $\overline{\text{WR}}$-input of the RTC.

The short program in Fig. 6 shows a sample source listing that performs a write operation to the RTC. After the program applies a counter reset, the RTC resets all internal timing counters, and then receives a chip select and write strobe from the bit set and clear commands.

For a read operation, the same sequence occurs except that Port A operates in its input mode and the $\overline{\text{RD}}$ line is pulsed. The read strobe is applied to the RTC with the address of the desired internal register on bits 0 through 4.

Somewhat the same techniques are used to read converted data from the ADC. When a conversion is desired, the CPU selects a channel and commands the ADC to start a conversion. Completion of the conversion produces an end-of-conversion signal that connects directly to the interrupt input, $\overline{\text{RSTA}}$, of the processor.

Power-save saves the battery's life

When operating, the system draws about 125 mW, dropping to just 70 mW in the power-save mode. If the system spent most of its time in the power-save mode, a 10 A-h battery pack would need charging only about once a month. Since readings are usually periodic, the ADC can take readings and the CPU can make its calculations in no more than a few milliseconds each period. Thus, the actual operating time could be just 3 to 5% of the total. If the batteries used in the system were nickel-cadmium with a 5 A-h rating, a battery life of 400 to 500 hours could be expected.

One factor limiting this lifespan is the battery's self-

A look at the NSC800 family

Three LSI circuits fabricated in National's high-performance P²CMOS process constitute the NSC800 family: the NSC800 CPU, the NSC810 combination RAM-I/O-timer and the NSC830 combination ROM-I/O circuit. The CPU combines the best features of both the Z80 and 8085 CPUs—the multiplexed bus of the 8085 and the instruction set and basic architecture of the Z80.

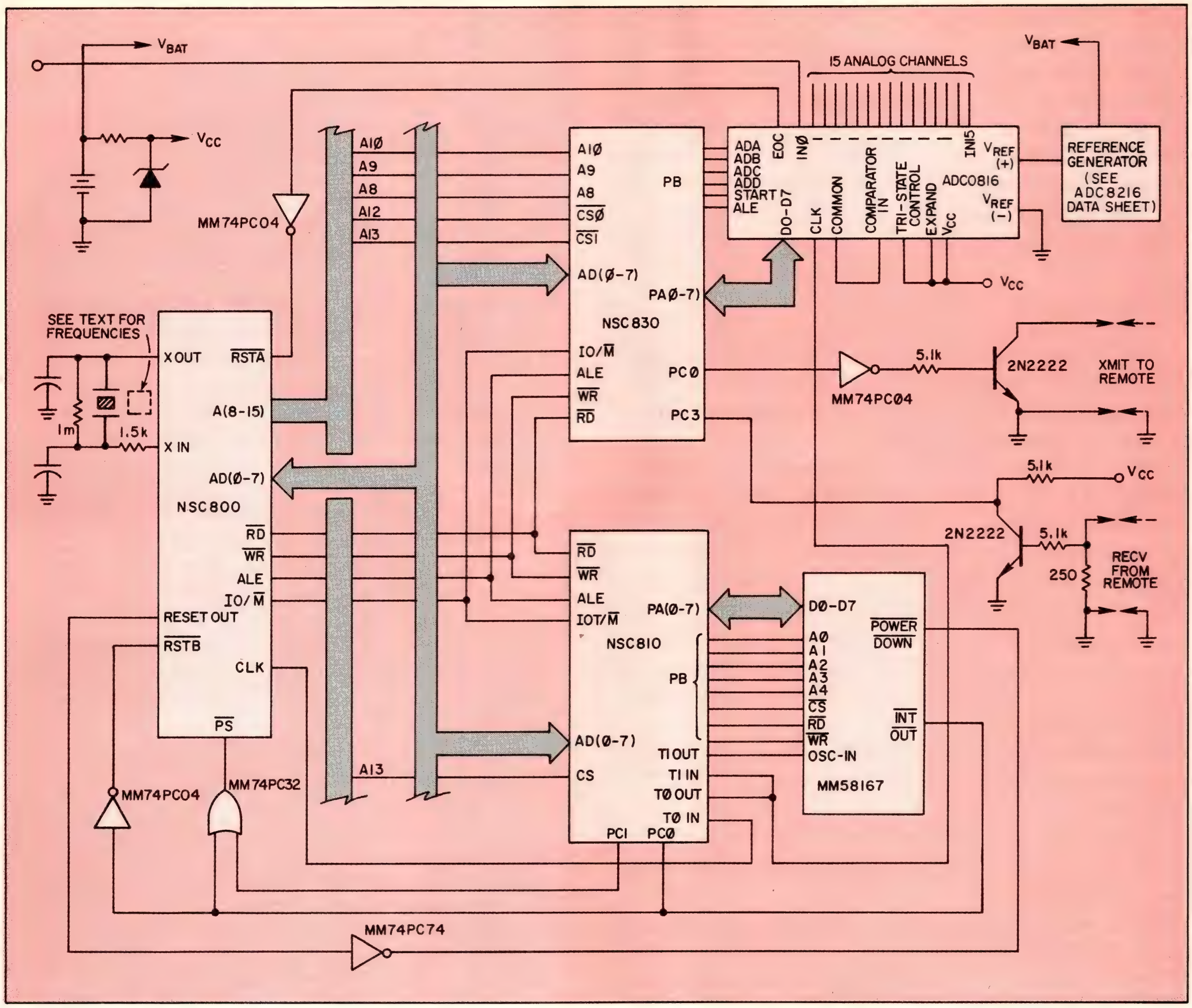
However in the NSC800, the RIM and SIM commands of the 8085 have been eliminated, along with the serial I/O lines. Instead, the 800 has a power-down control line and a refresh output that activates the 8-bit refresh capability of the CPU. Because the 800 is software compatible with the Z80, the names and polarities of several 8085 signals have been changed to Z80 nomenclature.

Although the internal architecture of the 800 provides complete compatibility with the Z80, the internal timing closely resembles that of the 8085—operations of the processor respond to the ALE signal rather than to the clock itself. In several ways the 800 improves on the 8085's timing: Output data are valid on both the leading and trailing edges of the Write signal, and the 800 automatically inserts a wait state during I/O cycles.

The 810 and 830 LSI support circuits are functionally similar to the 8155 and 8355 support circuits for the 8085 CPU. For example, the 810 provides RAM, I/O and two counter/timers. Although the RAM has half the capacity (just 128 bytes) of the 8155, it accesses in just 250 ns (the 8155 accesses in 400 ns). The timer sections include two prescaled 16-bit units instead of the single 14-bit counter/timer of the 8155. Like the NSC800, the 810 operates with a 4-MHz clock at a power dissipation level of 25 mW (at 5 V).

Each line of the 810's I/O ports (two 8-bit and one 4-bit) is individually programmable (the 8155 ports can be programmed only in blocks). Unlike the 8155, only one of the 810's ports offers strobed I/O. However, that one port can operate in three modes—input, output and three-state. Registers on the chip control the multimode port operation, as well as the timers and other port-line operations.

Like the 810, the 830 performs better than the equivalent NMOS device, the 8355. Offering a 2048-byte ROM with a 250-ns access time, the 830 has no need for the 8355's Ready signal. Also, the 830 combines the $\overline{\text{IOR}}$ function with one of two inputs provided for mask-programmable chip-enable lines. Thus, the user gets one more 4-bit port than with the 8355. The ports of the 830 function similarly to the ports of the 810, including multiple modes on one port.



5. A complete data-acquisition system can be put together by combining just five LSI circuits: the NSC800, 810 and 830; a 16-channel 8-bit a/d converter; and a real-time clock circuit. Since all circuits are CMOS, the entire system will operate intermittently from a 10 A-h battery for a month before the battery would need recharging.

```
LD      A,X'FF      ;Set Port A as output
OUT     DDRA,A      ;Store in Data Direction Reg.
OUT     DDRB,A      ;Same for Port B
LD      A,X'12      ;Select desired RTC address
OUT     PORTB,A     ;  for counter reset
LD      A,X'05      ;Data  for  bit  set  (bit  5)
OUT     PBSET,A     ;Set bit 5 to apply chip select
LD      A,X'07      ;Data  for  bit  set  (bit  7)
OUT     PBSET,A     ;Apply write strobe
OUT     PBCLR,A     ;Remove write strobe
LD      A,X'05
OUT     PBCLR,A     ;Remove chip select
```

6. This simple routine shows how the CPU controls the loading of data into the internal registers of the RTC by using the port output lines as strobe signals.

discharge characteristic, which can typically be as high as 30% of the charge for every month on the shelf. To counter this problem, the system includes one analog input that serves as a battery test line (IN_0). The source used in the system consists of seven cells stacked to provide 8.5 V. The converter is connected so that it can read the voltage on two of the cells.

Most manufacturers recommend that the cell should be recharged when the voltage drops below 1 V/cell. Recharging at this point prevents a total discharge. So, the analog input measures the two-cell voltage, say once an hour, and compares the result to a set value stored in memory. When battery power is low, the processor sends a warning over the serial link or sounds an alarm. ■■

How useful?	**Circle No.**
Immediate design application	**559**
Within the next year	**560**
Not applicable	**561**

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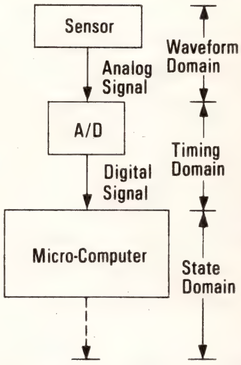

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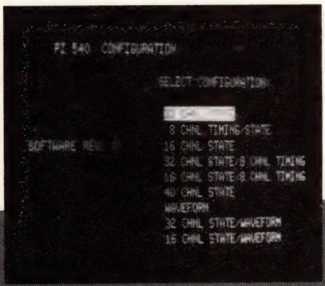
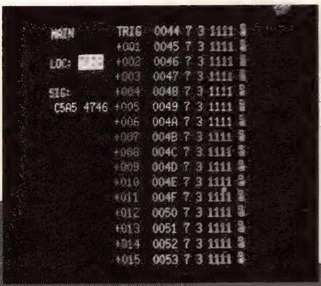


```
PI 540  CONFIGURATION

                    SELECT CONFIGURATION

                     [illegible]
                      8 CHNL TIMING/STATE
SOFTWARE REV. [illegible]  16 CHNL STATE
                     32 CHNL STATE/8 CHNL TIMING
                     16 CHNL STATE/8 CHNL TIMING
                     48 CHNL STATE
                     WAVEFORM
                     32 CHNL STATE/WAVEFORM
                     16 CHNL STATE/WAVEFORM
```



```
MAIN        TRIG  0044 7 3 1111
            +001  0045 7 3 1111
LOC: [illegible]  +002  0046 7 3 1111
            +003  0047 7 3 1111
SIG:        +004  0048 7 3 1111
 C5A5 4746  +005  0049 7 3 1111
            +006  004A 7 3 1111
            +007  004B 7 3 1111
            +008  004C 7 3 1111
            +009  004D 7 3 1111
            +010  004E 7 3 1111
            +011  004F 7 3 1111
            +012  0050 7 3 1111
            +013  0051 7 3 1111
            +014  0052 7 3 1111
            +015  0053 7 3 1111
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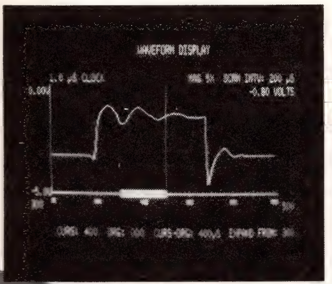

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Software techniques cram functions and data into pocket-sized μC applications

Here's a challenging design problem: Fit many functions into a limited ROM/RAM space, and design a data structure that provides enough data compaction and efficient access to the stored information. The solution consists of four sophisticated software techniques:

- An interpreter that crams a program into the smallest possible memory space
- Huffman encoding for word compaction that will minimize the needed storage
- A mapping algorithm that permits use of individual modules for each function while maintaining compatibility between all data-storage cartridges
- A symbol table with alphabetical ordering that simplifies searching for data.

To see how effectively this strategy can be implemented, examine the Craig M-100, a hand-held combination language translator and personal computer. It has three slots for ROM cartridges—2, 4 or 8-kbyte—that contain either dictionaries or programs (a 32-kbit dictionary ROM can take about 1200 words). The hardware (Fig. 1) consists of a single-chip F-8 microprocessor (the 3820), a 43-key keyboard, 16 characters of alphanumeric display, 32 bytes of external RAM and four external ROMs. Three of the ROMs are removable dictionary or program cartridges, while the fourth contains the translation program and a small starter dictionary.

The 3870 has 2048 bytes of on-board ROM and 64 bytes of RAM. Since the application program, excluding dictionaries, uses 96 bytes of RAM and about 5000 bytes of ROM, 1000 bytes are left for metric conversions and a simple starter vocabulary.

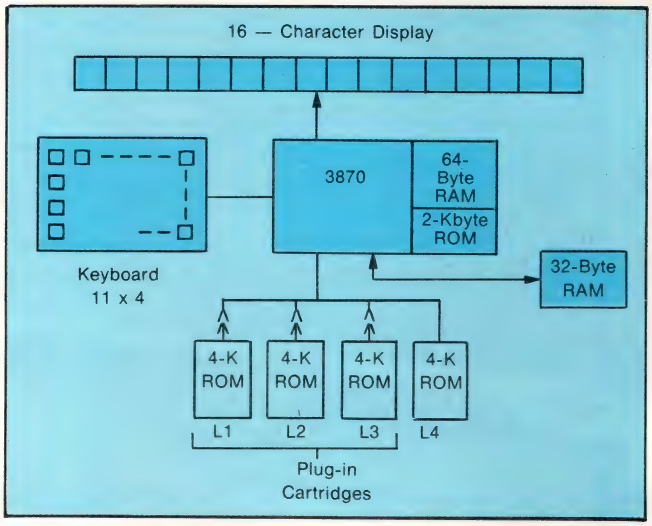
An interpreter for the interpreter

The 3870 does not have an external address bus, but interpretive instructions can be fed in over the data bus and executed every 2 milliseconds. In addition, since the 3870 cannot execute machine code from the external ROMs, the M-100 uses a Forth-like interpreter—not a specially designed interpreter, but an existing one adapted to execute Forth programs from the read-only memories.

Forth's 16-bit pointers have been modified to 8-bit tokens to enable the executable code to compress a great deal of function in a small space. This solution speeds up the design cycle drastically, by permitting the use of existing software and development tools. In addition to eliminating the time and effort needed to design and debug a new interpreter, the adaptation offers several other advantages:

- It permits running code from external ROM and removable cartridges, making the translator a general-purpose computer. And adding other features like a phonetic program cartridge is greatly simplified (see "Instant Translators—Who needs them?").
- Its stack orientation provides for efficient allocation of temporary variables.
- The modular, extensible form of a very simple interpreter permits the choice of a set of appropriate primitives—in this case, a subset of the standard Forth primitives plus some specialized ones for data compaction.
- Machine independence is provided so that future translators can use different processors and still be compatible with existing program cartridges.

The interpreter and machine-language kernel need about 800 bytes of code, leaving about 1250 bytes for



1. As the block diagram shows, the Craig M-100 translator has all the characteristics of a general-purpose computer: full keyboard, display, processing unit, RAM and exchangeable mass storage.

Paul Heckel, President, and **Richard Schroeppel,** Consultant, Interactive Systems Consultants, 666 South El Monte, Los Altos, CA 94305.

the data structure primitives. The interpretive code consists of a list of 8-bit tokens, each a number in the range of 0 through 255. The list is broken up into three ranges: Small numbers are interpreted as values to push onto the stack; intermediate numbers to index into a table containing the addresses of executable machine code; and high numbers to index into a table on external ROM (or cartridge ROM), which yields a string of tokens representing subroutines.

Programs or subroutines are stored as "postfix" bytes: the code "2 more 3 +" first pushes 2, then 3 on the stack, and finally executes the machine-code function ADD, which adds the top two numbers on the stack and replaces them with their sum. This reverse-Polish system is Forth's standard operating mode.[1,2,3]

Shoehorning the data

The most challenging technical problem in the M-100 is the data-structure design. Since the translator has one cartridge for each language, words and canned phrases in each language must be coordinated —for example, the word DOG is No. 17 in the English cartridge; PERRO, No. 17 in the Spanish cartridge; CHIEN, No. 17 in French, and so on. This system allows interchangeability among all languages: a Spanish cartridge can be used with a Norwegian cartridge as well as an English or a French one.

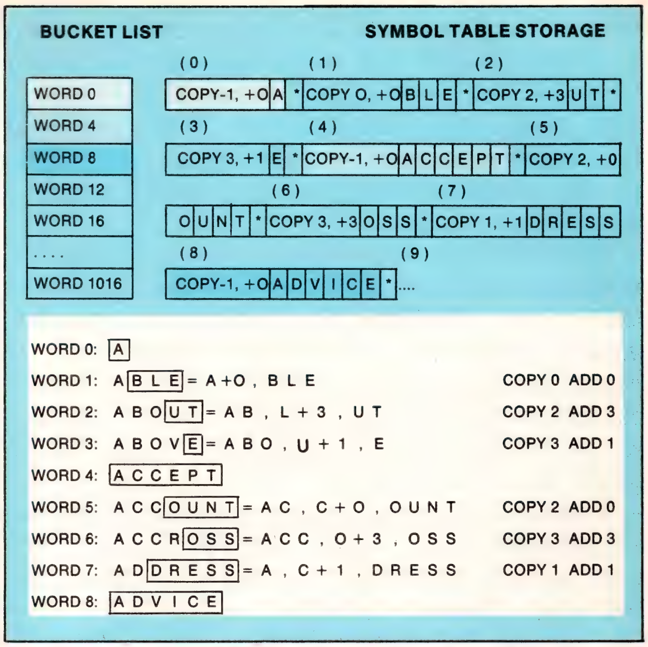
The coordinated approach requires the following access modes to the data structure:

- Given a word number, produce the word (e.g., given 37, produce DOG);
- Given a word, produce the word number (e.g., given DOG, produce 37).
- Given an initial string, produce all words that match (e.g., given DOG, produce DOG, DOGMA, DOGMATIC etc.)

There are two constraints. The dictionary needs an extremely compact structure to store the maximum number of words; and the structure's operations must be performed quickly, both for the initial dictionary of 1000 to 2500 words and for possible future expansion to even a million words. The solution: Dictionary words are stored in alphabetical order and a map table provides the mapping between language-invariant word numbers on one hand (DOG = 37; DOGMA = 946) and alphabetical positions on the other (DOG = 157; DOGMA = 158).

Alphabetical ordering allows symbol table references to be looked up in a time period proportional to $\log_2 N$, where N is the number of words in the dictionary. Since only about $\log_2 N$ words need be referenced for operations, the computational costs of referencing the compacted code are more acceptable than in other data structures where the factor would be N or N/2.

The words are in alphabetical order in the compacting algorithm. This fact can be exploited by the word encoding scheme to get back about 80% of the storage "cost" of the map table.


BUCKET LIST
SYMBOL TABLE STORAGE
WORD 0
WORD 4
WORD 8
WORD 12
WORD 16
. . . .
WORD 1016
(0)
(1)
(2)
COPY-1, +0 A * COPY 0, +0 B L E * COPY 2, +3 U T *
(3)
(4)
(5)
COPY 3, +1 E * COPY-1, +0 A C C E P T * COPY 2, +0
(6)
(7)
O U N T * COPY 3, +3 O S S * COPY 1, +1 D R E S S
(8)
(9)
COPY-1, +0 A D V I C E * ....
WORD 0: A
WORD 1: A B L E = A + O , B L E
COPY 0 ADD 0
WORD 2: A B O U T = A B , L + 3 , U T
COPY 2 ADD 3
WORD 3: A B O V E = A B O , U + 1 , E
COPY 3 ADD 1
WORD 4: A C C E P T
WORD 5: A C C O U N T = A C , C + O , O U N T
COPY 2 ADD 0
WORD 6: A C C R O S S = A C C , O + 3 , O S S
COPY 3 ADD 3
WORD 7: A D D R E S S = A , C + 1 , D R E S S
COPY 1 ADD 1
WORD 8: A D V I C E

2. Words are stored in ROM memory alphabetically, to cash in on the repetitive part of successive words. The table stores a variable, COPY, which specifies how many letters can be taken over from the preceding word. Another variable, ADD, determines the next letter, and only additional letters must be stored in full. The symbol asterisk serves as the word separator.

Symbol-table storage (Fig. 2) forms a "bucket list" that can point to every word numbered 2^B in alphabetical position (where 2^B = 1,2,4,8,16,32, etc.). Thus, word number W is in position (W mod B) in bucket number W/B. If the bucket size is 16, then DOG, in alphabetical position 157, word 13 in bucket 9:

$$9 \times 16 + 13 = 157.$$

Finding the language-invariant number of a word involves two searches: A binary search looks up the word, comparing the first word in each bucket to the target word. A linear search looks through the proper bucket for the target word. During the search, the algorithm keeps track of the current-word number and when the word is found, its alphabetical position number (DOG = 157) is converted to the language-invariant word number (DOG = 37).

Primitives for finding successive matches for a "target initial string" are constructed similarly. Given an initial target string of DOG, on repeated calls the primitive finds DOG, DOGMA, DOGMATIC, and so on.

What's the value of a word?

Unlike most symbol-table structures, the one in the M-100 does not contain an explicit value. Rather, the alphabetical-position number is a word's implicit "value" that can be mapped into the language-independent "logical" word number. However, the symbol-table construct allows a value to be stored following each word.

This data structure allows easy compaction of the table entries via a variant of Huffman encoding[4]— a simple method of generating variable-length "codons" for characters, so that often used characters have short codons and rarely used characters have long ones. The letter E, for example, might have the codon 01 and Z the codon 11011101. Given a particular text, codon generation is straightforward, even if (as in the translator) the maximum codon length is constrained to eight.

Improved compaction is possible because the probability of a particular character's occurring depends on the previous character. For example, in most languages vowels tend to follow consonants and vice versa. Using one set of Huffman codes to encode characters following consonants and another for characters following vowels reduces the average codon length significantly.

A class table, indexed by the current ASCII character, provides a class number that specifies the Huffman table to be used to decode the next character. Character classes are selected by trial and error when the language dictionaries are assembled. In practice, eight tables can profitably be used to get additional compaction, despite the memory cost of the additional Huffman tables.

Even further compaction is possible because the words are stored in alphabetical order. Each word is stored as a series of codons (C_1, C_2...C_N), each of which is a Huffman code; C_N is the codon that precedes the word separator.

The first codon (C_1) is unique in that its value in the decode table is not a 7-bit ASCII character but a 3-bit quantity called COPY and a 4-bit quantity called ADD: COPY indicates how many characters to copy from the previous word and ADD indicates the increment to convert the previous word's next letter to the current word's.

In Fig. 2, for example, the codon for the word ABOUT, C_1, contains COPY = 2, ADD = 3. Since the previous word was ABLE, COPY = 2 means that the first two characters, AB, are copied: ADD = 3 means that the next character is incremented by three in alphabetical sequence ($L + 3 \rightarrow O$). The result is ABO; the codons for U, T, and the word separator follow.

Since this structure is accessed via bucket-list pointers, the first codon for the first word in each bucket cannot refer back to the previous word. As a result, the first word in each bucket must be spelled out in full.

The Huffman tables are constructed in a way that minimizes storage needs. Each table consists of a list of 7-bit ASCII words in order from most to least frequently used characters. The Huffman code for the first character is computed from the header byte in

Instant translators—who needs them?

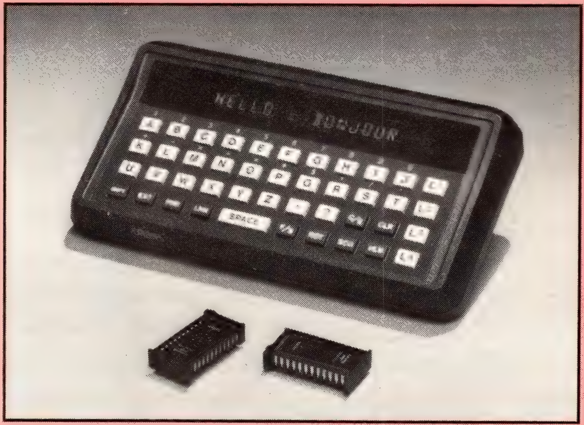
At first glance, an electronic translator looks like another gadget that will disappear as soon as the novelty has worn off. After all, can't pocket dictionaries do the same job for a fraction of the price —and with a much larger vocabulary, to boot?

The Craig translator does much more than a dictionary, because it interacts with the user. What's more, it can serve as a personal calculator.

For translation, the user may put, say, an English cartridge in slot 1 and a French one in slot 2, and translate from English to French or from French to English. If he then wishes to translate between English and Spanish he can either replace the French cartridge with a Spanish one or put a Spanish cartridge in slot 3.

To translate from the language in slot 2, the user hits the CLEAR key, and then the L2 key. He can now enter the words he wants translated, one by one. When finished, he hits the L1 key to translate into the slot-1 language. The machine responds with word-for-word translation—it does not know about plurals, tenses, genders or word orders. For example, the translated sentence might read PLEASE GIVE ME TWO APPLE RED. This translation may not be elegant, but it is adequate.

Another key feature of the translator is its search capability. If a user types in a word that the translator does not have in its dictionary, it can search for similar words—for instance, by displaying all words in the dictionary that differ only in the last letter. If none is found, it will delete the last character from the word the user entered, and search again.



This feature is very useful in catching spelling errors and handling grammar: plurals, verb tenses and gender endings in foreign languages. Anticipating user needs is very important in designing a system like the M-100.[7]

Homographs also pose no problem. For example, there are two entries for the word "watch": WATCH (SEE) and WATCH (CLOCK). When the user types WATCH, the SEARCH key displays both alternatives, letting him choose the one he wants.

The general-purpose nature of the M-100 permits easy implementation of special features. For instance, the third slot can be used for a phonetic display that works with four languages: French, German, Italian and Spanish. After, say, RED has been translated into ROUGE, pressing the L3 button will yield ROOJ.

the Huffman table. The Huffman code for other entries is computed from the Huffman code of the previous entry and the previous byte's high-order bit.

In Fig. 3, the header byte contains a right-justified mask (00000111), which specifies the length of the tentative codon for the first possible character, E. The codon for the first character is always all ZEROs—in the example, 000. The character can be decoded if this tentative codon matches the beginning of the bit stream being decoded—i.e., if the string being decoded begins with 000. The pointer to the bit stream is then advanced to point immediately after the matched codon so that word decoding can continue.

If, however, the codon does not match the beginning of the bit stream, the next tentative codon is computed by first incrementing the tentative codon by 1. Thus, 000 would become 001, or 0001 would become 0010. Next, if the high-order bit of the unmatched character is set, the tentative codon is shifted left by 1, increasing its length—000 would become 0010 or 0001 would become 00100. The new tentative codon can now be compared with the beginning of the bit stream, and the process continues until the tentative codon matches the beginning of the bit stream. The corresponding character then can be output from the Huffman decode table and the bit stream pointer advanced past the just-matched codon (Fig. 4).

At first, this procedure seems awkward and slow since it requires a serial search of the decode table for each character. However, the characters are stored in order of frequency, and with about 4 bits used to encode a character (4.6 bits including the table overhead), finding a character takes an average about half the time it takes to search a 16-word (2^4-bit) table. Consequently, only the time it takes to step through eight entries is needed.

Mapping the words

To understand the mapping algorithm, assume 1024 (2^{10}) words are stored in a dictionary. One could store the map table as 1024 entries of 10 bits, which are accessed by index for mapping in one direction and serially searched for mapping in the other direction. But this approach has two problems:

1. A linear search through 1024 entries would take a time proportional to the number of words in the dictionary—the bigger the dictionary, the more prohibitive the search time.
2. The resulting data structure would use a constant entry size, presenting some implementation problems. For example, if 1025 instead of 1024 words were to be stored, a wasteful 11-bit entry would be needed.

This problem can be solved with a bidirectional bit-mapping algorithm.[5,6] The algorithm assumes that a bit space of approximately $N(\log_2 N - 1.5)$ bits has been set up appropriately and performs about $2 \log_2 N$ operations to map from an alphabetical position to a logical word number and vice versa. This algorithm also saves about 1.5 bits per word, resulting in 8.5 bits for each of the 1024 words.

Mathematically speaking, the algorithm simply permutes a set of elements; in effect it reorders a list of distinct words (or numbers)—each item must appear once and only once in each list. The basic elements of the system are crossbars (Fig. 5a), which specify the two possible two-element permutations. Think of a permutation as wires going in the left side of the diagram and coming out the right side in (possibly) different positions. The two mappings in Fig. 5a, parallel (=) and cross (×), seem trival, but as the number increases, the picture gets complex.

Fortunately, it is possible to recursively build up a permutation of 2^{N+1} elements from a permutation of 2^N elements. In Fig. 5b, the algorithm specifies the wires connecting the boxes; the data in the map table specify which of the two crossbar elements shown in Fig. 5a should be placed in each of the empty boxes.

The language compiler can easily "fill the boxes" for a given permutation. For example, assume the desired permutation is 0213. Box A is always set to =; and × or an = must be assigned to B, C and D. (Ignore Y and Z for the time being). Following element 0 from box A to the Y box, the permutation must continue to the top entry on the C box. So an = must be put in box C to complete this connection. Now, following element 2 back from box C through Z and B, an × must be assigned to box B. Again following

00000111		
0	E	CODON E = 000 = 0 AND 00000111
0	T	CODON T = 001 = 000 + 1
1	I	CODON I = 010 = 001 + 1
0	O	CODON O = 0110 = 010 + 1 SHIFT LEFT
0	N	CODON N = 0111 = 0110 + 1
0	S	CODON S = 1000 = 0111 + 1
1	H	CODON H = 1001 = 1000 + 1
	-1	10100 = 1001 + 1 SHIFT LEFT
0	U	CODON U = 101000 = 10100 SHIFT LEFT

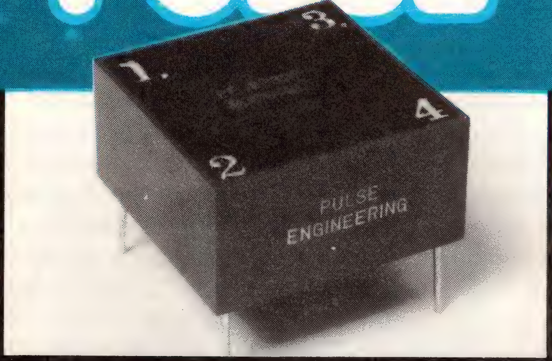
THE WORD THE WOULD BE CODED AS 001, 1001, 000
OR JUST 0011001000

3. Huffman codons are short for frequently used letters like E and get longer as usage frequency drops. Thus, the word "the," which is made up of common characters, needs just 10 bits, compared to 21 in ASCII.

01000001000	No match
01000001000	No match
01000001000	Found B
B 00001000	No match
B 00001000	Found E
B E 001000	No match
B E 001000	Found E
B E E 1000	No match
B E E 1000	No match
B E E 1000	No match
B E E 1000	Found R
B E E R	

4. To decode a word, first look up a bit stream in the Huffman table to see if there is an entry for the word. If not, the number of bits is increased until a match is found. In this case, the first match is 010 (B), followed by the codons for E and R. The word is now ready for display.

NEW FROM PULSE



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Electrical specifications at 25°C unless specified

Catalog Number Low Profile	Rated RMS Current (AMPS) (1) At Any Input Voltage	Max. VA at RMS Line Voltage 117	220	Inductance at 1KHz (Mhy Min.)	DCR Max. Each WDG (OHMS)	Package Number
PE 62891	1.8	210	420	10.0	0.240	1
PE 62892	3.5	400	800	3.0	0.060	1
PE 62893	6.0	700	1400	1.0	0.020	1
PE 62894	2.6	300	600	16.0	0.160	2
PE 62895	3.2	375	750	8.0	0.120	2
PE 62896	5.2	600	1200	4.0	0.040	2
PE 62897	7.5	815	1750	2.0	0.020	2

Data Subject to Change Without Notice
*Packages:
1. L=1.25", W=1.25", H=.600"
2. L=1.5", W=1.5", H=.800"

(1) VA rating for normal operation at 117 V RMS line. For 230 V RMS line VA ratings are approximately doubled. Caution — do not exceed rated RMS current ratings.

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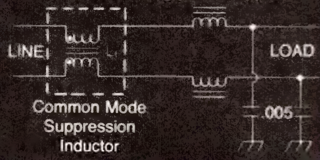
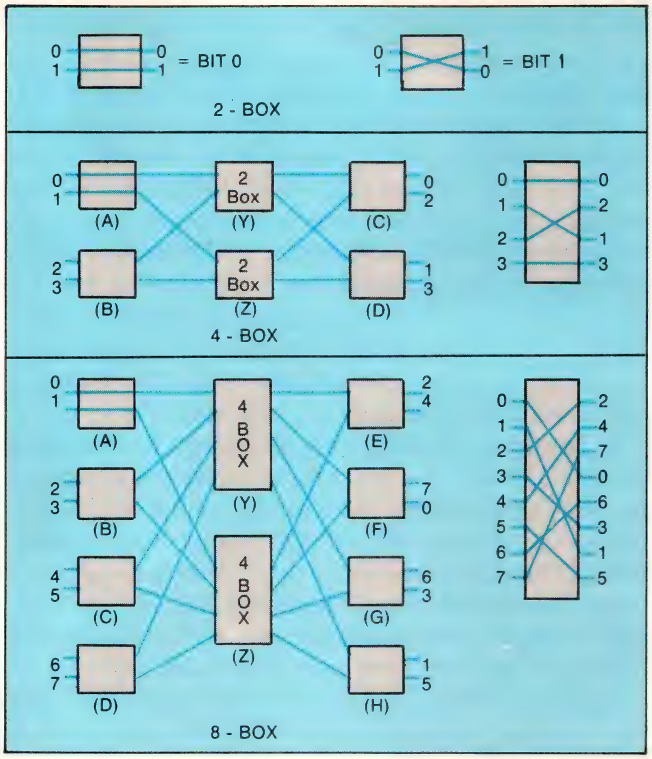
CIRCLE NUMBER 57

Typical input filter used with switching power supplies





5. Conversion from alphabetic to logical word numbers and vice versa is done with a bidirectional bit-mapping algorithm, which has two basic elements (a). The mapping process is easy to do by hand when only a "4-box" results (b), but larger boxes are best solved with a recursive algorithm, as described in the text (c).

element 3 from box B to D, an = must be assigned to D. The remaining line, 1, maps from box A to box D, and all that's left to be done is to specify boxes Y and Z.

In this case the choice is obvious: Y gets an = and Z an ×. In general, however, "filling in" X and Y is a recursive problem as demonstrated in Fig. 5c for an eight-element permutation with two 4-boxes. The first step is to write down a permutation on the right side and then repeat the above procedure, alternately filling in boxes on the right and left sides and then recursively solving the permutations for the two central 4-boxes.■■

References

1. Moore, C.H., and Rather, E.D., "The Forth Program for Spectral Line Observing." *Proceedings of the IEEE*, September, 1973, pp. 1346-1349.

2. Sinclair, W.S., "The Forth Approach to Operating Systems," *ACM '76 Proceedings*, October, 1976, pp. 223-246.

3. James, John, "Forth for Microcomputers," *ACM SILPLAN Notices*, October, 1978.

4. Huffman, D.A., "Method of Construction of Minimal-redundancy Codes," *Proceedings of the IRE*, September, 1952, p. 1098.

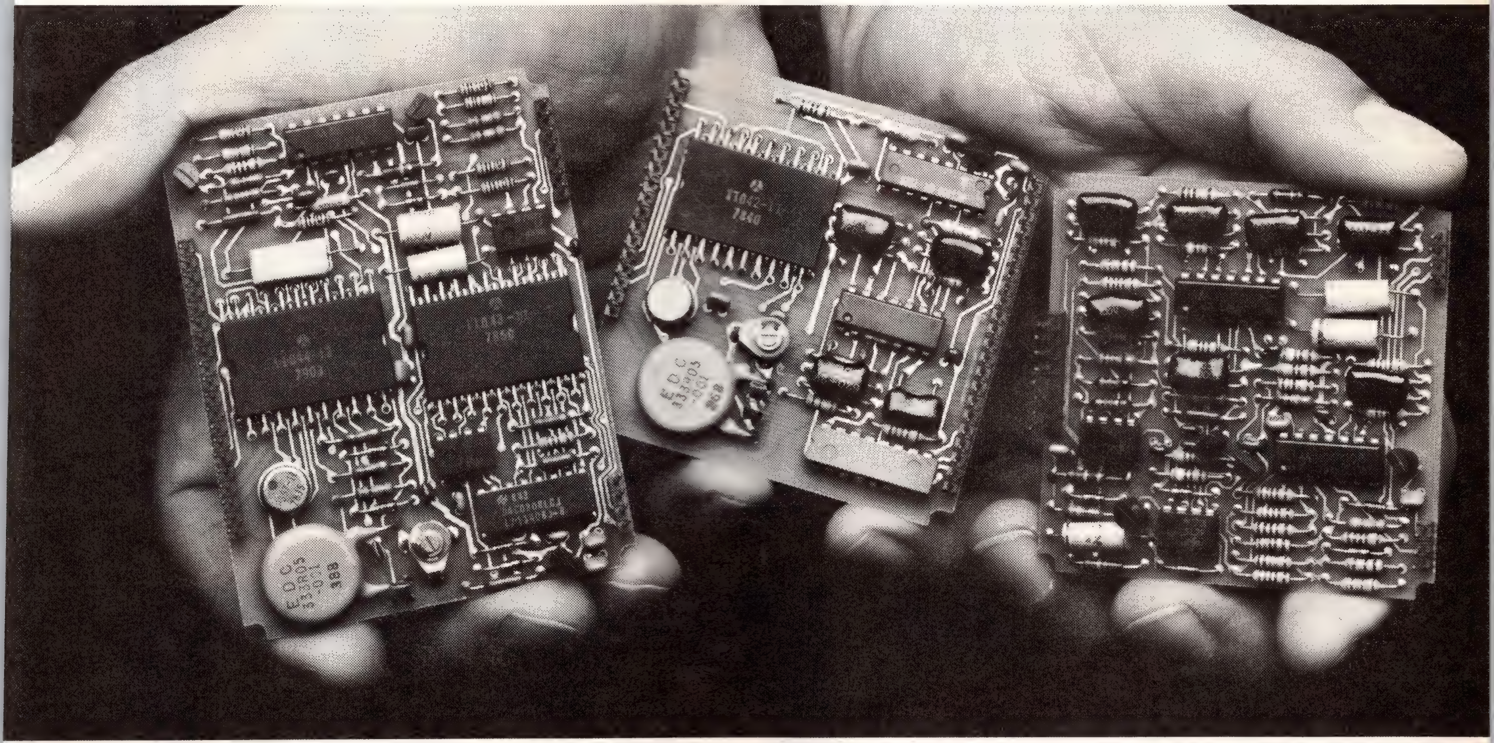
5. Knuth, Donald E., *The Art of Computer Programming*, Vol. 4, p. 24. Addison-Wesley, Reading, MA, 1977.

6. Benes, V.F., *Mathematical Theory of Connecting Networks and Telephone Traffic*, Academic Press, New York, 1965.

7. Heckel, Paul, "Designing Translator Software," *Datamation*, February, 1980, p. 134.

How useful?	**Circle No.**
Immediate design application	**562**
Within the next year	**563**
Not applicable	**564**

R24. The first 2400 bps modular modem.



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CIRCLE NUMBER 58

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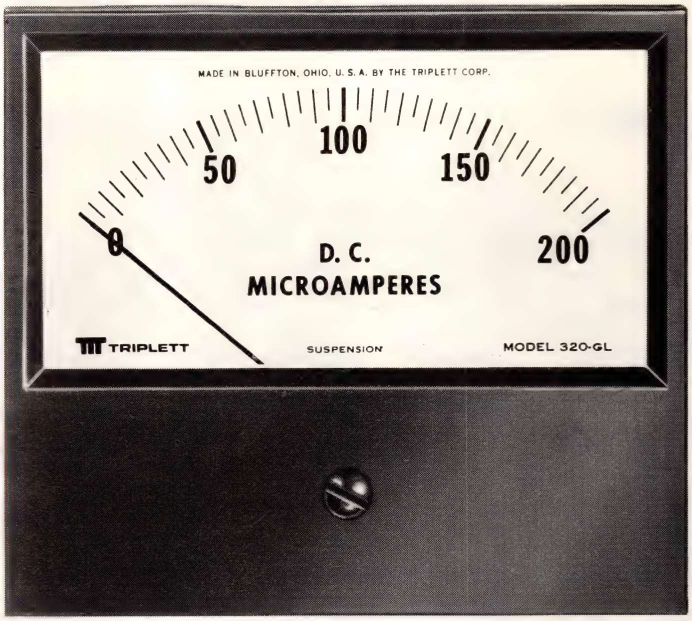

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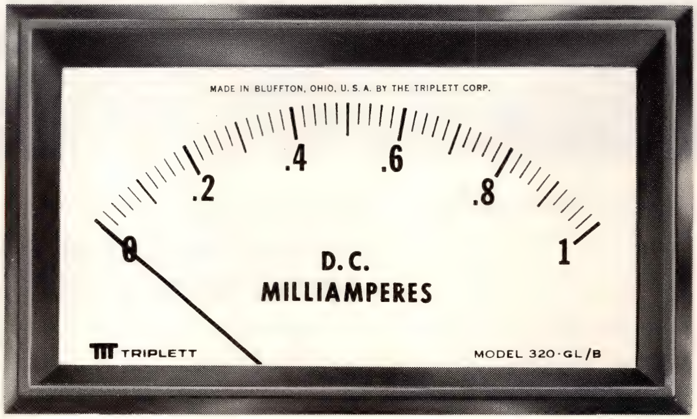

GL/B (mounted appearance)

Triplett's newest panel instruments, the Series GL and GL/B, feature glass windows, matte-finish phenolic cases and a dial design that can readily accommodate multiple scales. They are available in 3½", 4½" and 5½" sizes.

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CIRCLE NUMBER 59 FOR INFORMATION

CIRCLE NUMBER 60 FOR FREE DEMONSTRATION

Simple circuit and software replace PROM programmer for 6800-based systems

In the development of software for microprocessor-based systems, debugged software must often be transferred to PROM for later use in the system. It is preferable to write in the system's PROM directly from the system's RAM, instead of copying down the contents of the RAM and then writing them into an external PROM with a PROM programmer. The advantages of direct transfer are realized easily with just two transistors, a flip-flop and a few resistors, which connect a 2708/2704 PROM to the peripheral interface adapter (PIA) used in systems based on the 6800. The required programming can reside in the system monitor or in any other areas designated by the user.

The resident software (see listing) presents the address, data bits and the program pulse to the PROM through a 6820 PIA. Programming waveforms are created exactly as recommended by the PROM manufacturer. After the address and data are set up, one program pulse per address is applied to the PROM's program input (pin 18). One scan through all addresses constitutes a program loop. One hundred program loops are required as per the manufacturer's data sheet.

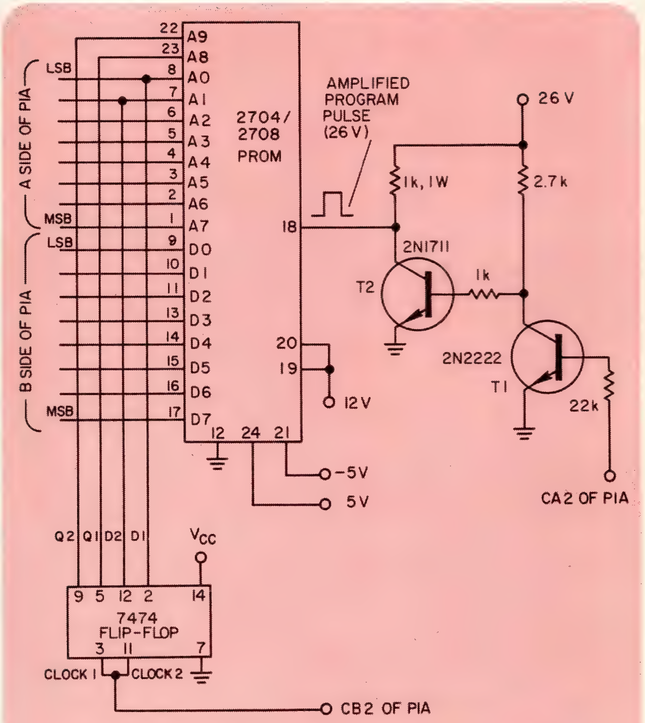
Before executing the program, the user must supply the starting address of the data source (RAM) and the starting and ending address where data are to be written (PROM), and must account for the data invert/normal option. The program terminates with an RTS instruction, which returns control to the monitor.

Transistors T_1 and T_2 (see schematic) amplify the program pulse transmitted by the 6800 to a 26-V level for the 2708/2704 PROM. The 7474 flip-flop expands the word length of port A and provides ten address bits simultaneously to the PROM. Data bits are presented to the PROM through Port B of the PIA. CA_2 and CB_2 of the PIA are defined as outputs: CA_2 supplies the program pulse, and CB_2 provides the flip-flop clock pulse.

The cost for all the additional hardware is about \$3—a negligible amount when compared to the cost of a microprocessor development system. The circuit and software have been tested only with a 6800 microprocessor system and a 2708/2704 PROM. However, any PROM should be programmable using this technique, if appropriate changes are made in the hardware and software.

Victor Mathew and James Thomas, R&D Engineers, OEN India Ltd., Vyttila, P.B. No. 2, Cochin-682 019 Kerala, India.

CIRCLE NO. 311



With only a few components, the 2704/2708 PROM connects to a 6800-system's peripheral interface adapter (PIA) for direct software transfer. The "A side" of the PIA (and the flip-flop) outputs address bits; the "B side" outputs data.

(continued on page 156)

```
            * PIA INITIALISATION *

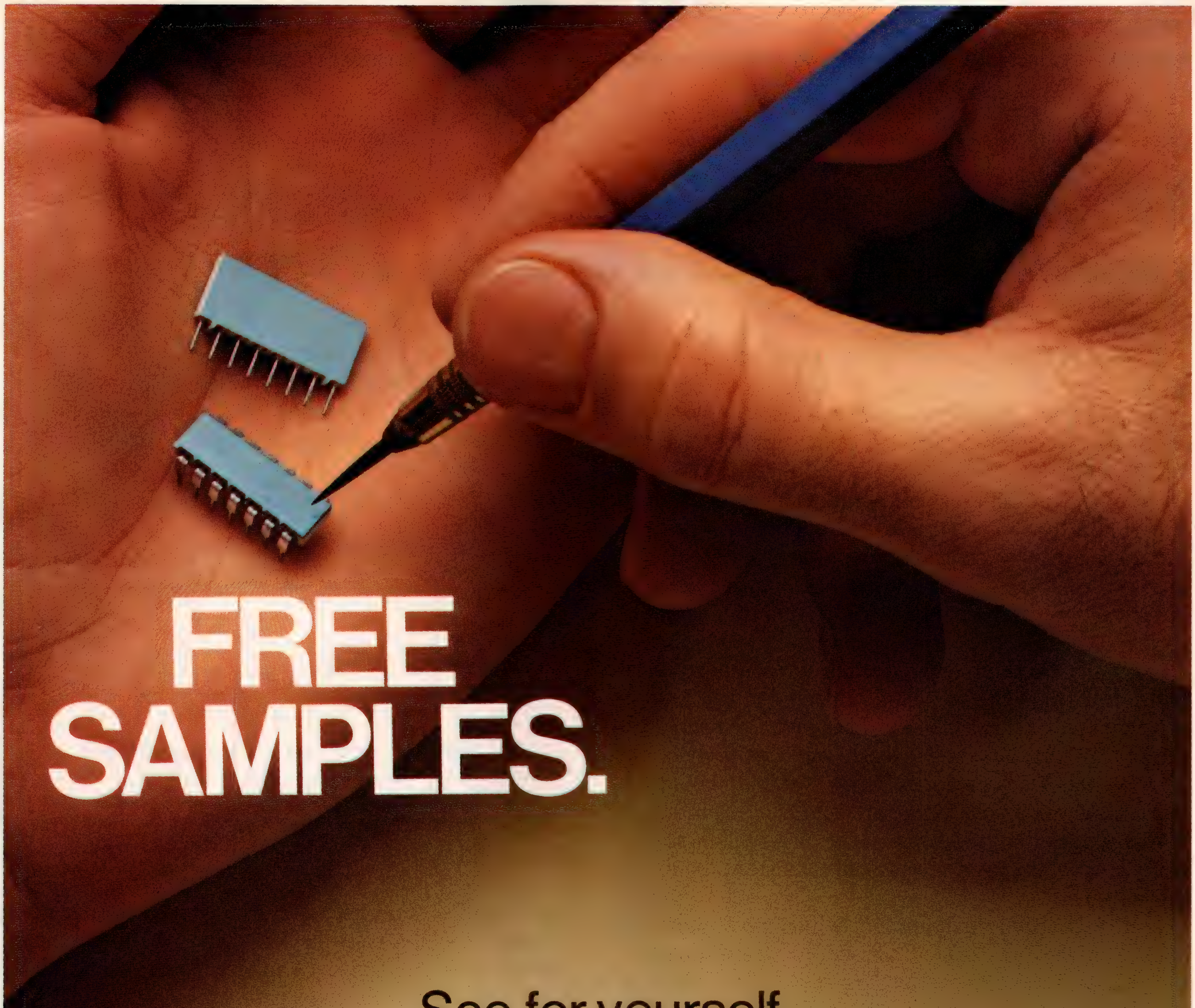
1000  4F                     CLR A          :DEFINE A AND B SIDE OF PIA AS OUTPUT
1001  97 C0                  STA A           CONTROL PORT A SIDE=00C0
1003  86 FF                  LDA A           CONTROL PORT B SIDE=00C1
1005  97 80                  STA A           OUTPUT PORT  A SIDE=0080
1007  86 04                  LDA A           OUTPUT PORT  B SIDE=0081
1009  97 C0                  STA A
100B  4F                     CLR A
100C  97 C1                  STA A
100E  86 FF                  LDA A
1010  97 81                  STA A
1012  86 04                  LDA A
1014  97 C1                  STA A

            * MAIN *
1016  5F                     CLR B          :LOOP COUNTER INITIALISE
1017  DE 00        LOOP2     LDX            :RAM START ADDR.AT 0000/0001
1019  DF 07                  STX            :PRESENT RAM ADDR.STORED
101B  DE 02                  LDX            :PROM START ADDR.AT 0002/0003
101D  DF 09                  STX            :PROM PRESENT ADDR.STORED
101F  96 09        LOOP1     LDA A          :OUTPUT HIGH BYTE ADDR.OF PROM
1021  97 80                  STA A
1023  86 3C                  LDA A
1025  97 C1                  STA A          :CB2 PULSE GOES HIGH
1027  8D 35                  BSR            :250 MICROSECOND DELAY SUBROUTINE
1029  86 34                  LDA A          :CB2 PULSE GOES LOW
102B  97 C1                  STA A
102D  96 0A                  LDA A          :OUTPUT LOW BYTE ADDR.OF PROM
102F  97 80                  STA A
1031  DE 07                  LDX            :RAM START ADDR.
1033  A6 00                  LDA A
1035  7D 0006                TST            :TEST ADDR.0006 FOR DATA-NORMAL/INVERT
1038  27 01                  BEQ     NORM   :DATA NORMAL
103A  43                     COM A          :DATA INVERT
103B  97 81        NORM      STA A
103D  8D 1F                  BSR            :250 MICROSECOND DELAY SUBROUTINE
103F  86 3C                  LDA A          :CA2 PULSE GOES HIGH
1041  97 C0                  STA A
1043  8D 26                  BSR            :1MILLISECOND DELAY SUBROUTINE
1045  86 34                  LDA A          :CA2 PULSE GOES LOW
1047  97 C0                  STA A
1049  8D 13                  BSR            :250 MICROSECOND DELAY SUBROUTINE
104B  08                     INX            :INCREMENT RAM ADDR.
104C  DF 07                  STX
104E  DE 09                  LDX
1050  08                     INX            :INCREMENT ROM ADDR.
1051  DF 09                  STX
1053  09                     DEX
1054  9C 04                  CPX            :CHECK FOR PROM ADDR.AT 0004/0005
1056  26 C7                  BNE     LOOP1  :CHECK FOR LOOP END
1058  5C                     INC B          :INCREMENT LOOP COUNTER
1059  C1 64                  CMP B          :CHECK FOR 100 LOOPS
105B  26 BA                  BNE     LOOP2
105D  39                     RTS

            *250 MICROSECOND DELAY SUBROUTINE*
105E  7F 000B                CLR            :INITIALISE COUNTER FOR DELAY
1061  7C 000B      LOOP3     INC
1064  96 0B                  LDA A
1066  81 0F                  CMP A
1068  26 F7                  BNE     LOOP3
106A  39                     RTS

            *1 MILLISECOND DELAY SUBROUTINE*
106B  7F 000B                CLR            :INITIALISECOUNTER FOR DELAY
106E  7C 000B      LOOP4     INC
1071  96 0B                  LDA A
1073  81 40                  CMP A
1075  26 F7                  BNE     LOOP4
1077  39                     RTS
```

The programming required for direct transfer of debugged software from RAM to PROM can reside in the system monitor or in any other areas designated by the user.



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CIRCLE NUMBER 61

Simple Hall-effect tachometer measures rotational speeds directly in rps or rpm

A simple tachometer giving not only revolutions per second but also revolutions per minute can be constructed using a Hall-effect switch, a frequency counter (or oscilloscope), a battery, a load resistor, and a small bar magnet.

Mounting the magnet on a rotating shaft so that it periodically comes close to the switch generates a square wave pulse, whose frequency is directly related to speed of rotation. The frequency counter gives a direct readout in rps—simply multiply by 60 to obtain rpm.

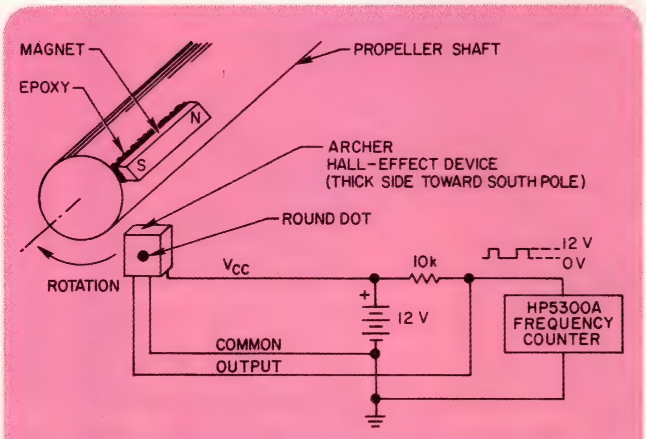
Normally the Hall-effect switch is open (output is high). But when the switch is subjected to the proper magnetic pole, the output switches low. Connected as shown, the output swings clearly and distinctly from 12 V to approximately 0 V. Such a swing should be more than adequate for most frequency counters.

The counter used here, an HP5300A, has a sensitivity control that can be set until consistent readouts are obtained.

In the original tachometer, which was built to determine the rpm of a submersed thruster propeller, the magnet is epoxied to the thruster shaft. The Hall-effect switch is encased in RTV and cemented in place, with its leads brought outside the test tank for connection to the battery and frequency counter.

The Hall-effect switch, available in local electronics stores, switches only in the presence of a magnetic South pole. North pole switches do exist, so the device spec sheet should be consulted to determine which magnetic polarity is required.

Note that the bar magnet could unbalance the machine it is attached to. However, a few ounces of magnet are negligible compared to the large mass of the propeller. Furthermore, the magnet is located ½ in. from the shaft center line (the thruster propeller swings around a 13-in. diameter). Under these conditions, counter-balancing is unnecessary.


MAGNET
EPOXY
N
S
PROPELLER SHAFT
ARCHER HALL-EFFECT DEVICE (THICK SIDE TOWARD SOUTH POLE)
ROUND DOT
ROTATION
V_{CC}
10k
12 V
0 V
+
12 V
HP5300A FREQUENCY COUNTER
COMMON
OUTPUT

A Hall-effect device is superior to magnetic-reed switches for reliable high-speed switching operations. Here, shaft revolutions to 3000 rpm can be measured without difficulty.

An oscilloscope may be used instead of a frequency counter. The counter works satisfactorily to about 2200 rpm while a scope proves superior at higher speeds. Note also that the pulse width derived from the switch decreases as rpm increases, and the HP5300A does not readout consistently with the thinner, high-rpm pulses.

Rogert J. Decesari, Electronics Engineer, Hydro Products, 11777 Sorrento Valley Rd., San Diego, CA 92121.

CIRCLE NO. 313

IFD Winner for December 20, 1979

Bob Haver, Strategic Marketing Engineer, Motorola, SPG, Phoenix, AZ 85008. His idea "Current Capacity of Three-terminal Regulator Expands Fivefold" has been voted the Most Valuable of Issue Awards.

Vote for the Best Idea in this issue by circling the number of your selection on the Reader Service Card at the back of this issue.

SEND US YOUR IDEAS FOR DESIGN. You may win a grand total of $1050. Here's how. Submit your IFD describing a new and important circuit or design technique, the clever use of a new component or test equipment, packaging tips, cost-saving ideas to our Ideas for Design editor. Ideas can only be considered for publication if they are submitted exclusively to ELECTRONIC DESIGN. You will receive $20 for each published idea, $30 more if it is voted best of issue by our readers. The best-of-issue winners become eligible for the Idea of the Year award of $1000.

ELECTRONIC DESIGN cannot assume responsibility for circuits shown nor represent freedom from patent infringement.

10

Announcing the "Top Ten"

The Electronic Design 1980 Top Ten Contest winning advertisements are displayed on the following pages.

In 1980, as in the past, thousands of Electronic Design subscribers around the world tried to out-guess our Reader Recall Survey — Electronic Design's proven method of measuring readership.

How the "Top Ten" were chosen.

The number of readers who recalled having seen a given ad determined the winners. For each advertisement, points were totalled to determine ranking.

Watch your mail.

Right now, we're determining which reader entries most nearly match this ranking. Meanwhile, you can page through the ads to see how you did. You could be a winner, perhaps of the Grand Prize — a Windjammer Cruise For Two and $1,000 Cash. Individual winners will be notified by mail.

What makes an award-winning advertisement?

As you will notice on the following pages, the winning ads combine well-written copy with superior design to achieve impact and memorability.

Here are the "Top Ten" winners:

1. Advanced Micro Devices
2. National Semiconductor
3. Intel Corporation
4. Precision Monolithics
5. Dale Electronics
6. Guardian Electric Manufacturing Company
7. Intersil
8. Standard Microsystems Corporation
9. American Microsystems
10. Garry Manufacturing

Electronic Design

intel®
3636

16K Speed Champ

Intel's new 3636 bipolar PROM breaks the 16K speed barrier with 65ns access. It's a victory for bit slice designs.

Streamlined performance is the whole point of today's advanced bit slice computers. High speed. High density. High reliability. Now Intel delivers the 16K 3636, manufactured with our new Stacked Fuse Bipolar* process to produce the highest performance microprogram memory yet.

Design for speed and comfort

Our 2Kx8-bit 3636 gives you four times the density of 4K bipolar PROMs with no speed penalty. The 3636's maximum access of 65ns makes it the ideal memory for fast, high density bit slice designs, as well as look-up table and other program store applications.

Using the 3636 instead of 4K PROMs lets you reduce component count and microprogram board requirements up to 75%. By designing program store on the CPU board, you can even save up to a full board slot for I/O or other functions.

For designs requiring extended temperature ranges, our 80ns military device, the M3636, is ideal.

No matter what your application, you're certain to reduce power requirements. Power consumption per bit for the 3636 is only one fourth that of most 4K bipolar PROMs and only half that of most 8Ks.

Whether you're replacing 4K or 8K bipolar devices, the 3636 makes it simple. It's packaged in the industry standard 24-pin DIP, so you won't have to redesign in order to upgrade.

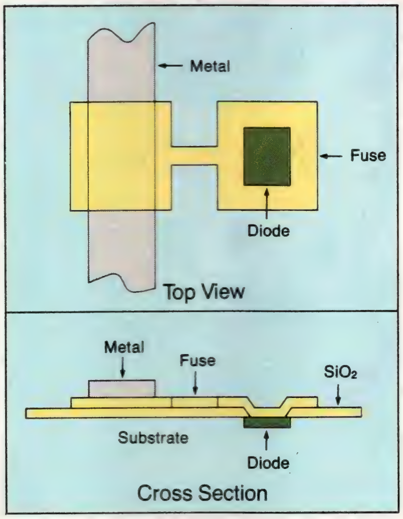
And you can program the 3636 in seconds using Intel's UPP103 or any standard PROM programmer.

Our formula: Stacked Fuse Bipolar

The most efficient way to improve speed characteristics of bipolar PROM's is to reduce die size. Very simply, smaller geometries reduce capacitance, thus speeding access time.

Intel achieved the 3636's high speed and dramatically smaller die size with a new "stacked" bipolar process. Stacked Fuse Bipolar combines Intel's expertise in Large Scale Integration with dual layer metalization and polysilicon fuses. (See diagram.) The result is the highest density and performance ever in a 16K bipolar PROM.

Stacked Polysilicon Fuse



Intel's new Stacked Fuse Bipolar process allows a 30% reduction in the 16K cell size. This dramatic density improvement yields faster access speeds than ever before possible. The illustration shows the "stacking" of our polysilicon fuse over the diode instead of placing them side by side as in older designs.

Intel's 3636 Bipolar PROMs			
	3636-1	3636	M3636
Maximum Access Time (ns)	65	80	80
Typical Power Per Bit (mW)	0.05	0.05	0.05

Intel's 3636 also means high reliability. We've already proven the producibility and dependability of Stacked Fuse technology with our 3625A 4K bipolar PROM. Hundreds of thousands of these components are already in operation, including military versions for hi-rel applications. In addition, millions of device-hours of tests with zero fuse failures confirm Stacked Fuse Bipolar's reliability. Further details on Intel's bipolar PROM reliability are found in our Summary Evaluation Report, RE1, available on request.

Get on the fast track today

Our high performance 3636 is available now. To order, or for complete data and reliability information, contact your local distributor or Intel sales office. Or write Intel Corporation, Literature Department, 3065 Bowers Avenue, Santa Clara, California 95051. Or call (408) 987-8080.

intel® delivers.

Europe: Intel International, Brussels, Belgium. Japan: Intel Japan, Tokyo. United States and Canadian distributors: Arrow Electronics, Alliance, Almac/Stroum, Component Specialties, Cramer, Hamilton/Avnet, Harvey, Industrial Components, Pioneer, Wyle/Elmar, Wyle/Liberty, L.A. Varah and Zentronics.

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1980 TOP TEN ADVERTISERS

CIRCLE NUMBER 62

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*Stacked Fuse Bipolar is a patented process of Intel Corporation.

PMI Creates a Rosy New Variety of Analog Switches

In the Linear Wonderland garden, one coat of BIFET covers a lot of CMOS whitewash

© PMI 1979

In Lewis Carroll's Wonderland, no one was more dreaded than the Queen. She dealt with anyone who crossed her path by ordering their beheading. The gardeners on her croquet court (the Two, Five and Seven from a deck of playing cards) were well aware of the risks.

"Would you tell me please," said Alice, a little timidly, "why you are painting those roses?"

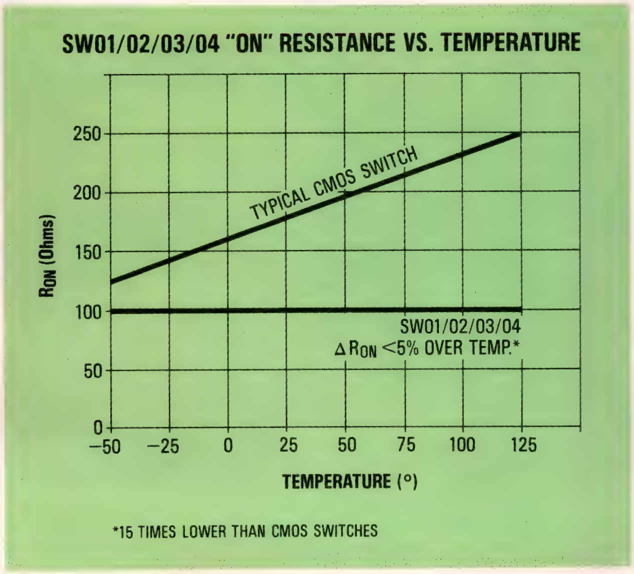
Two began, in a low voice, "The fact is, Miss, this here ought to have been a red rose tree and we put a white one in by mistake. If the Queen was to find out, we should all have our heads cut off."

In Linear Wonderland, engineers who pick their analog switches from the CMOS tree are often tempted to yell, "Off with their heads!," just as the Queen did when she found out her red roses weren't really red. What brings out the executioner instinct in every engineer are the thorny problems with "ON" resistance and voltage overload typical of CMOS analog switches.

When PMI decided to get into the analog switch market, we were determined not to lose our heads. So we looked at the best species of analog switches on the market and decided engineers would find them more attractive if they were grafted with PMI's proven BIFET technology, the same process used in our prized Multiplexer variety of circuits. It wasn't just a cover-up paint job, though; we started at the beginning and created something new: a family of Quad BIFET analog switches that fit the most popular CMOS pinouts but are more rugged electronically than CMOS can ever be.

Consider PMI's SW01/02/03/04. They're Quad BIFET analog switches with temperature-compensated R_{ON} coefficient (0.03%/°C), low R_{ON} vs. voltage (~4%) *and* a low absolute R_{ON} (100Ω maximum at 25°C). That's better performance than you get from CMOS, or even from the other BIFET switches on the market. In addition, you get low leakage (~0.2nA) and the protection against blowout that is inherent with PMI's BIFET technology.

ATTENTION DG201 USERS!


SW01/02/03/04 "ON" RESISTANCE VS. TEMPERATURE

*15 TIMES LOWER THAN CMOS SWITCHES

We didn't stop there, however. We know that most engineers are as forward-thinking as the White Queen in *Through the Looking Glass,* who told Alice her favorite things are those that happened the week after next. We kept going and developed the 7510/7511 analog switches which were designed to be pin-compatible with the well-known CMOS AD7510/11. These also eliminate the static discharge sensitivity in CMOS devices, improve leakage currents over temperature by two to five times, and there's no need for pull-up resistors to maintain TTL logic thresholds.

All in all, we think we've got the most beautiful Analog Switch Tree anywhere in Linear Wonderland. To prove it, we'd like you to use the coupon for your "BLOOMIN' SWITCH SAMPLE."

You'll find out that those CMOS guys don't have enough paint in their buckets to gloss over the advantages of PMI's Quad BIFET analog switches. The next time they try, you'll know what to say.

"Off with their heads!"

If someone beat you to the coupon, write to us for **your sample. Or circle #201 for literature.**

SW01	—Normally ON, no disable. (Pin compatible to both DG201 and LF11201.)
SW02	—Normally OFF, no disable. (Pin compatible to the LF11202.)
SW03	—Normally ON, with disable.
SW04	—Normally OFF, with disable.
SW7510	—Normally OFF. (Pin compatible with the AD7510.)
SW7511	—Normally ON. (Pin compatible with the AD7511.)

Precision Monolithics, Incorporated
1500 Space Park Drive
Santa Clara, California 95050
(408) 246-9222 TWX: 910-338-0528 Cable: MONO

In Europe contact:
Precision Monolithics, Incorporated
c/o Bourns Ag
ZUGERSTRASSE 74, 6340 Baar, Switzerland
Phone: 042/33 33 33 Telex: 78722

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ELECTRONIC DESIGN
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Check the box for the "BLOOMIN' SWITCH SAMPLE" you'd like to have.

☐ SW01 – Normally ON, no disable. ☐ SW02 – Normally OFF, no disable.
☐ SW03 – Normally ON, with disable. ☐ SW04 – Normally OFF, with disable.
☐ SW7510 – Normally OFF. ☐ SW7511 – Normally ON.
I am now using: ☐ DG201 ☐ HI201 ☐ LF11201 ☐ LF11202

Mail to: **Precision Monolithics, Inc.,** 1500 Space Park Drive, Santa Clara, CA 95050

or: **Precision Monolithics, Inc.,** c/o Bourns Ag
Zugerstrasse 74, 6340 Baar, Switzerland

My name____________________

Title____________________

Company____________________

Dept.____________________

Address____________________

____

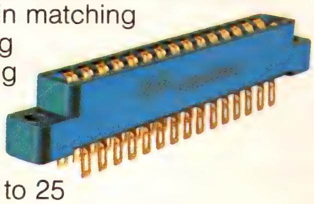
Phone (________) ____________________

4-ED 5112

CIRCLE NUMBER 201

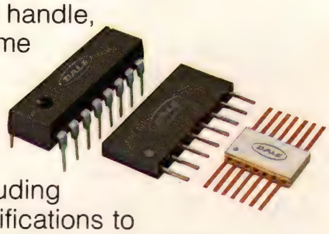
An edge for versatility

Dale .156″ Edgeboard Connectors give you extra freedom in matching body materials, mounting variations, contact plating and termination styles. Choose from double or single readouts, .140″ or .200″ row spacing, 6 to 25 contact positions. Instant interchangeability with major connector manufacturers. Phone 605-665-9301 or Circle **350**



Compact and qualified

Dale Thick Film Networks give you resistance that's easy to handle, package and afford. Name what you need: DIP, flatpack or SIP styles (.195″ or .350″ profile). They're ready in all popular schematics including the widest range of qualifications to MIL-R-83401. Thick film chip resistors, too. Phone 402-371-0080 or Circle **351**



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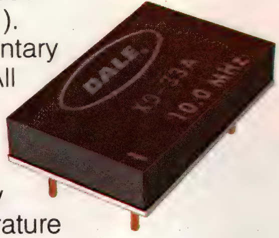
DALE ELECTRONICS, INC., Box 609, Columbus, Nebraska 68601

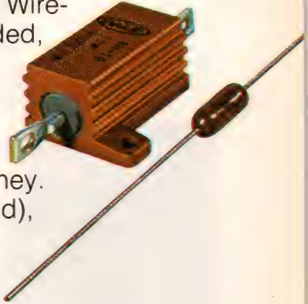
When timing is important

Dale Clock Oscillators are ready from stock in a choice of prices and profiles (as low as .200″). Functions include complementary output and enable/disable. All have 14-pin DIP configuration and TTL compatibility. Standard frequencies from 250 KHz to 25 MHz. Stability from .005% to 2.5%. Temperature compensated styles also available. Phone 602-967-7875 or Circle **352**



Maturity where it counts

Dale Resistors give you one-source efficiency for the industry's widest choice of commercial, precision and E-Rel styles. Wirewound, metal film, coated, molded, housed. We can deliver **any** resistance function you need backed by the kind of quality and effective technical support that can save you time and money. Phone 402-564-3131 (wirewound), 402-371-0080 (metal film) or Circle **353**



The many faces of Dale.

Get to know them better.

DALE®

A subsidiary of The Lionel Corporation IN CANADA: Dale Electronics, Ltd. IN EUROPE: Dale Electronics GmbH, 8301 Puchheim, West Germany

Whose MCU does 8-bit jobs on a

AMI's S2000 FAMILY, OF COURSE.

With power packed into every square mil of its tiny frame, our mighty microcomputer family is saving the day everywhere you look. From industrial controls on one end of the spectrum to handheld games on the other, our 4-bit wonder is proving to be as versatile as it is cost-conscious.

No other low-end, single chip microcomputer family can handle the jobs Mighty MOS can. Controlling programmable thermostats for industry, pay-TV scrambler boxes, fuel gauges and instrument panels. Running washers, dryers, dishwashers, refrigerators and microwave ovens. And masterminding timers for the home that will turn on lights, sprinkler systems and security monitors.

In one application after another, Mighty MOS is finding more holes in the competition than Swiss cheese.

WHAT GIVES MIGHTY MOS THE EDGE?

It's not only powerful enough to take care of many 8-bit jobs. It's also crafty enough to handle many things other 4-bit microcomputers can't.

Our tiny champion of oppressed engineers has a clear edge in I/O, with a choice of LED or fluorescent drivers; Touch Control; or direct drive of SCR and Triac. It has a 50/60 Hz timer or counter, zero voltage crossing to cut down damaging current surges, and a three-level subroutine stack.

And Mighty MOS is the only 4-bit MCU supported by the Tektronix 8002A development system. That gives it more programming muscle, too.

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DESIGN
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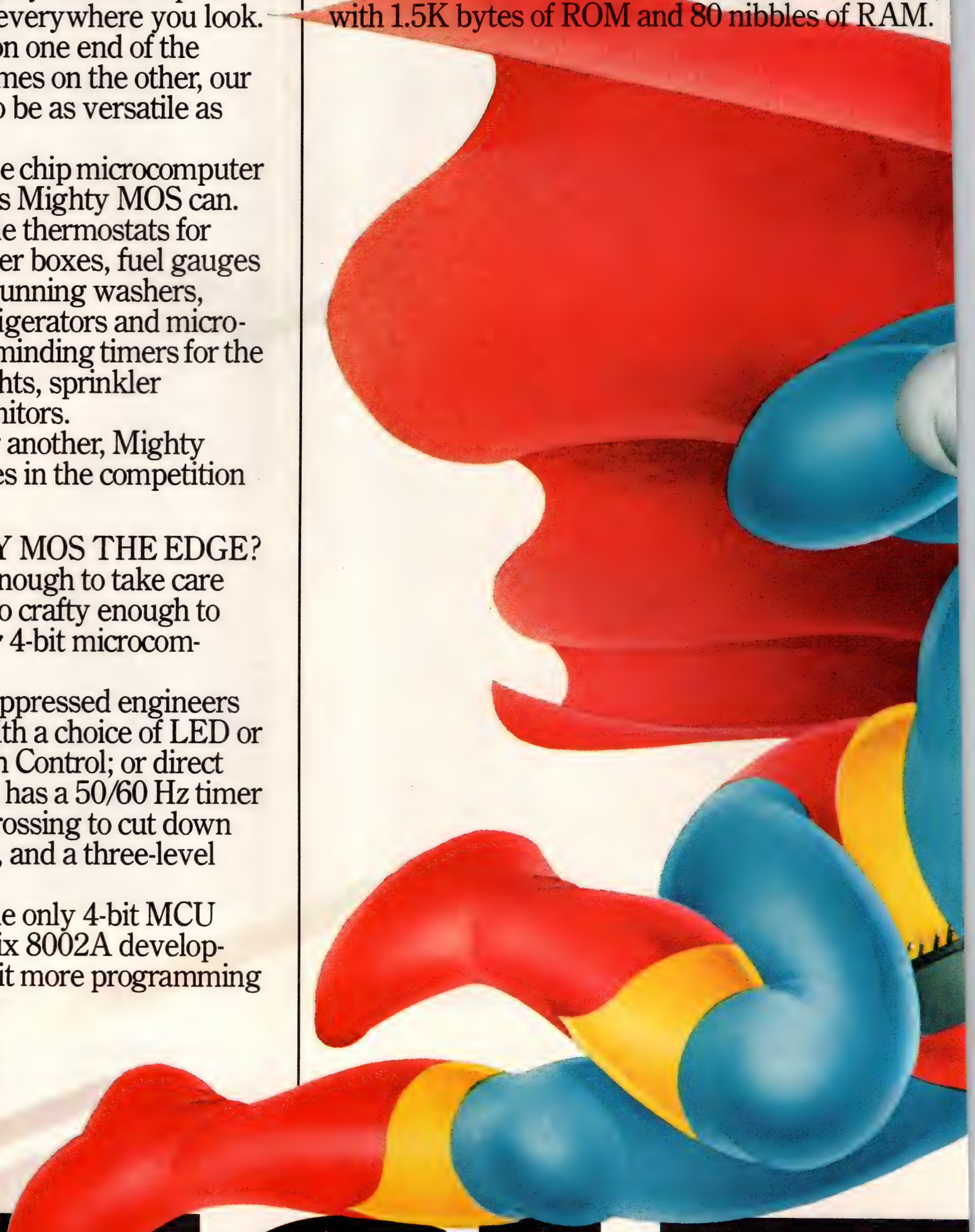
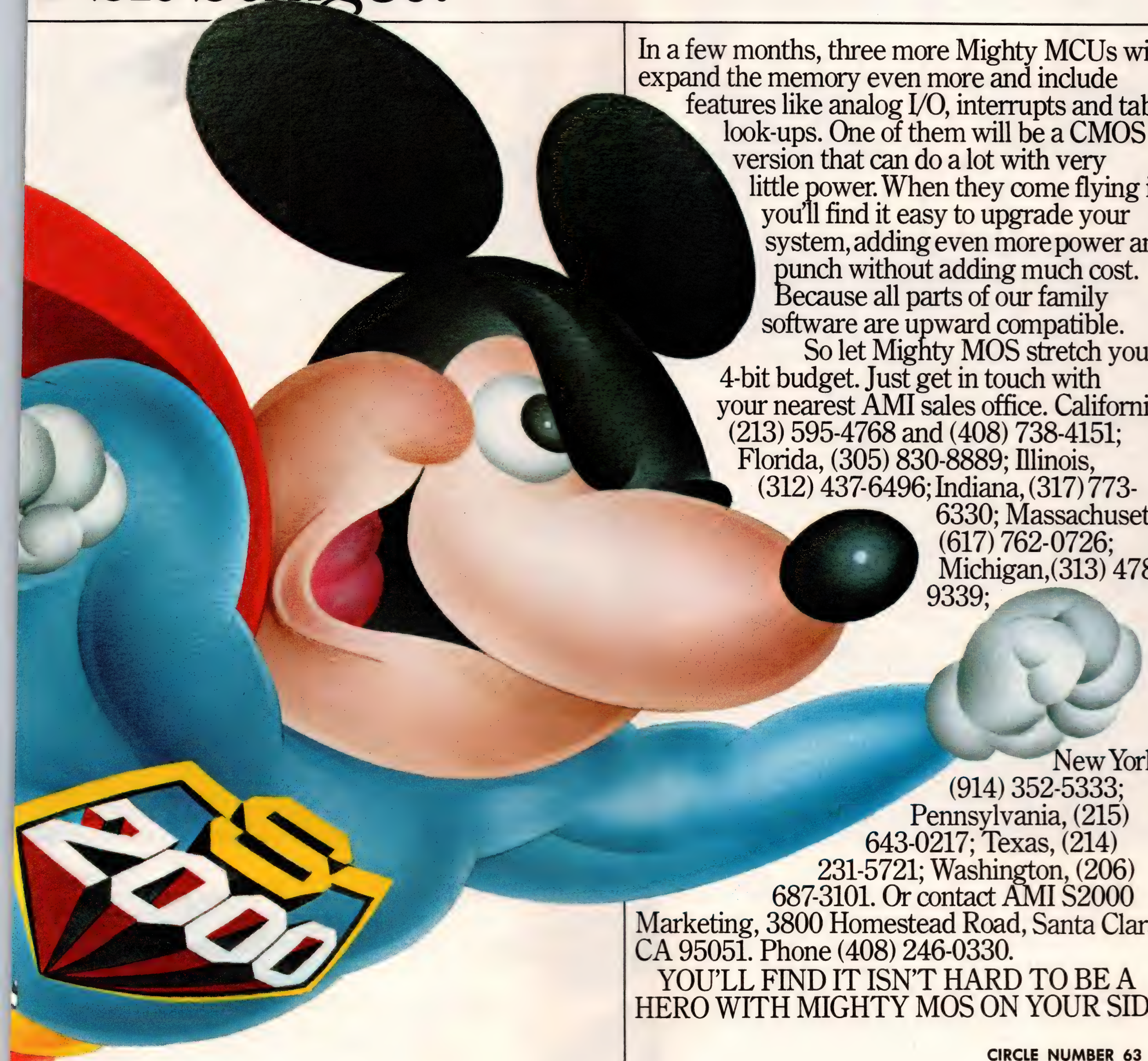
ADVERTISERS

MIGHTY MOS IS GROWING FAST.

You can order S2000s now with built-in 1Kx8 ROM and 64 4-bit nibbles of RAM. And S2150s, with 1.5K bytes of ROM and 80 nibbles of RAM.



MIGHT



4-bit budget?

In a few months, three more Mighty MCUs will expand the memory even more and include features like analog I/O, interrupts and table look-ups. One of them will be a CMOS version that can do a lot with very little power. When they come flying in, you'll find it easy to upgrade your system, adding even more power and punch without adding much cost. Because all parts of our family software are upward compatible.

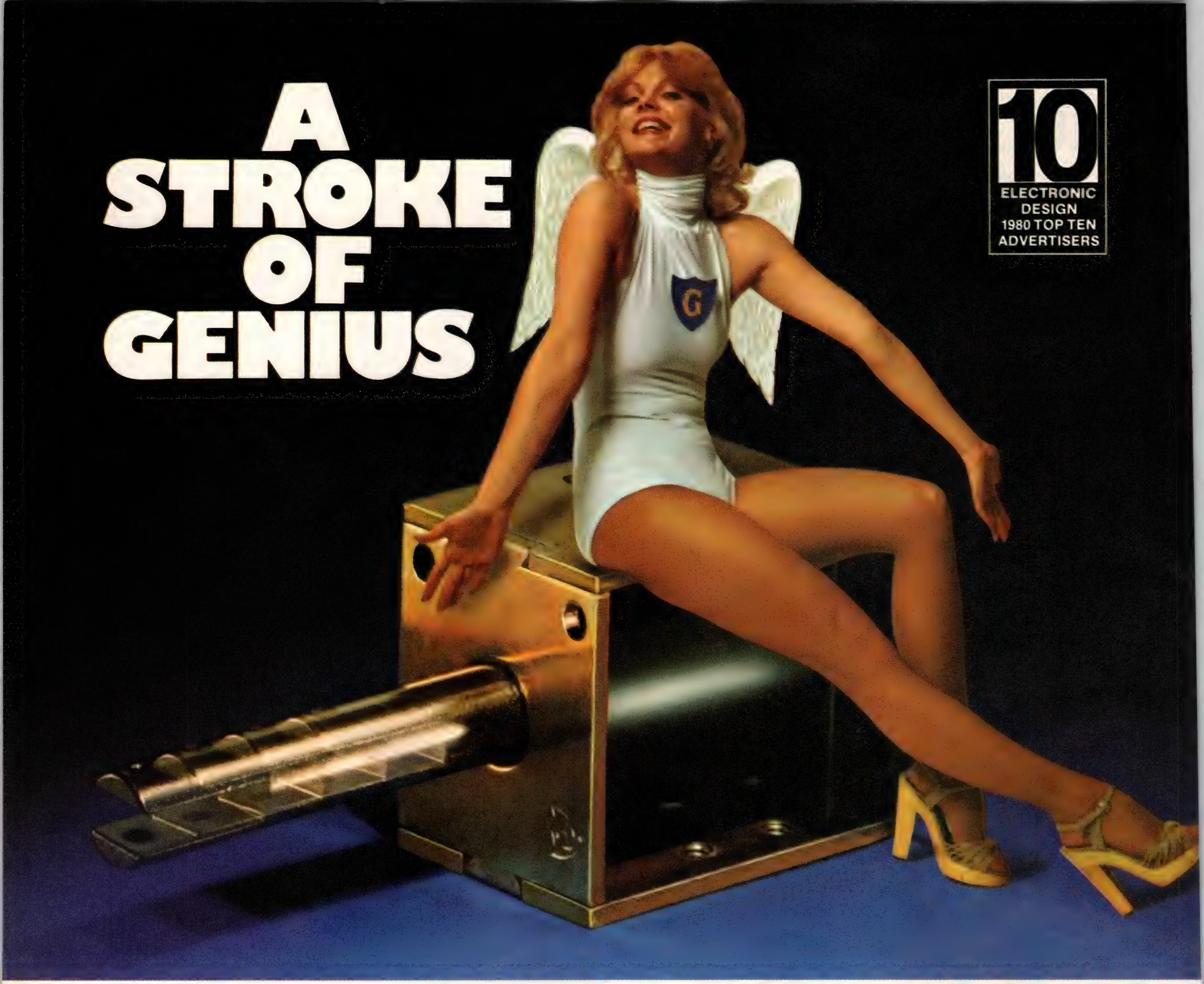
So let Mighty MOS stretch your 4-bit budget. Just get in touch with your nearest AMI sales office. California, (213) 595-4768 and (408) 738-4151; Florida, (305) 830-8889; Illinois, (312) 437-6496; Indiana, (317) 773-6330; Massachusetts, (617) 762-0726; Michigan, (313) 478-9339; New York, (914) 352-5333; Pennsylvania, (215) 643-0217; Texas, (214) 231-5721; Washington, (206) 687-3101. Or contact AMI S2000 Marketing, 3800 Homestead Road, Santa Clara CA 95051. Phone (408) 246-0330.

YOU'LL FIND IT ISN'T HARD TO BE A HERO WITH MIGHTY MOS ON YOUR SIDE.

CIRCLE NUMBER 63

AMI®
AMERICAN MICROSYSTEMS, INC.

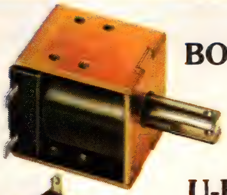
Y MOS



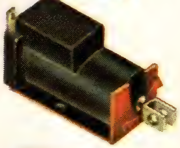
Need a stroke of an inch-and-a-half... or just one thirty-secondth? Need pull of 50 pounds...or just a fraction of an ounce? AC or DC? Intermittent or continuous duty? Pull or push? Box-frame, U-frame, laminated or tubular? Recognition under the component program of Underwriters' Laboratories, Inc.?

Guardian's got 'em all. And each features meticulous craftsmanship . . . true engineering genius. (Inspired, of course, by your very own Guardian Angel.)

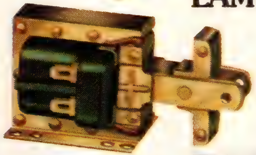
SEND FOR CATALOG.



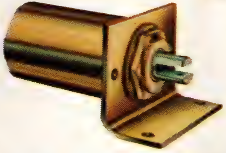
BOX-FRAME SOLENOIDS with Uni-Guard® II molded bobbin and coil covers...mechanical life measured in millions of cycles.



U-FRAME SOLENOIDS for minimum cost with high reliability...most with Uni-Guard® II molded bobbin and coil covers.



LAMINATED SOLENOIDS in AC only for more pull over a longer stroke than DC solenoids of the same size...many with Uni-Guard® molded polyester coil covers.



TUBULAR SOLENOIDS in your choice of premium quality long life of up to 100 million operations or more...or traditional tubulars with an expected life of a million operations plus.

SOLENOIDS IN MORE TYPES...WITH MORE INSPIRED DESIGN...THAN ANYONE ELSE IN THE WORLD.

GUARDIAN®

GUARDIAN ELECTRIC MANUFACTURING COMPANY • 1550 West Carroll Ave., Chicago, Illinois 60607 • 312/243-1100

CIRCLE NUMBER 64

No. 4

NATIONAL ANTHEM

SEMICONDUCTOR NEWS FROM THE PRACTICAL WIZARDS OF SILICON VALLEY

New 12μW LM385

Lowest power reference available.

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ELECTRONIC DESIGN
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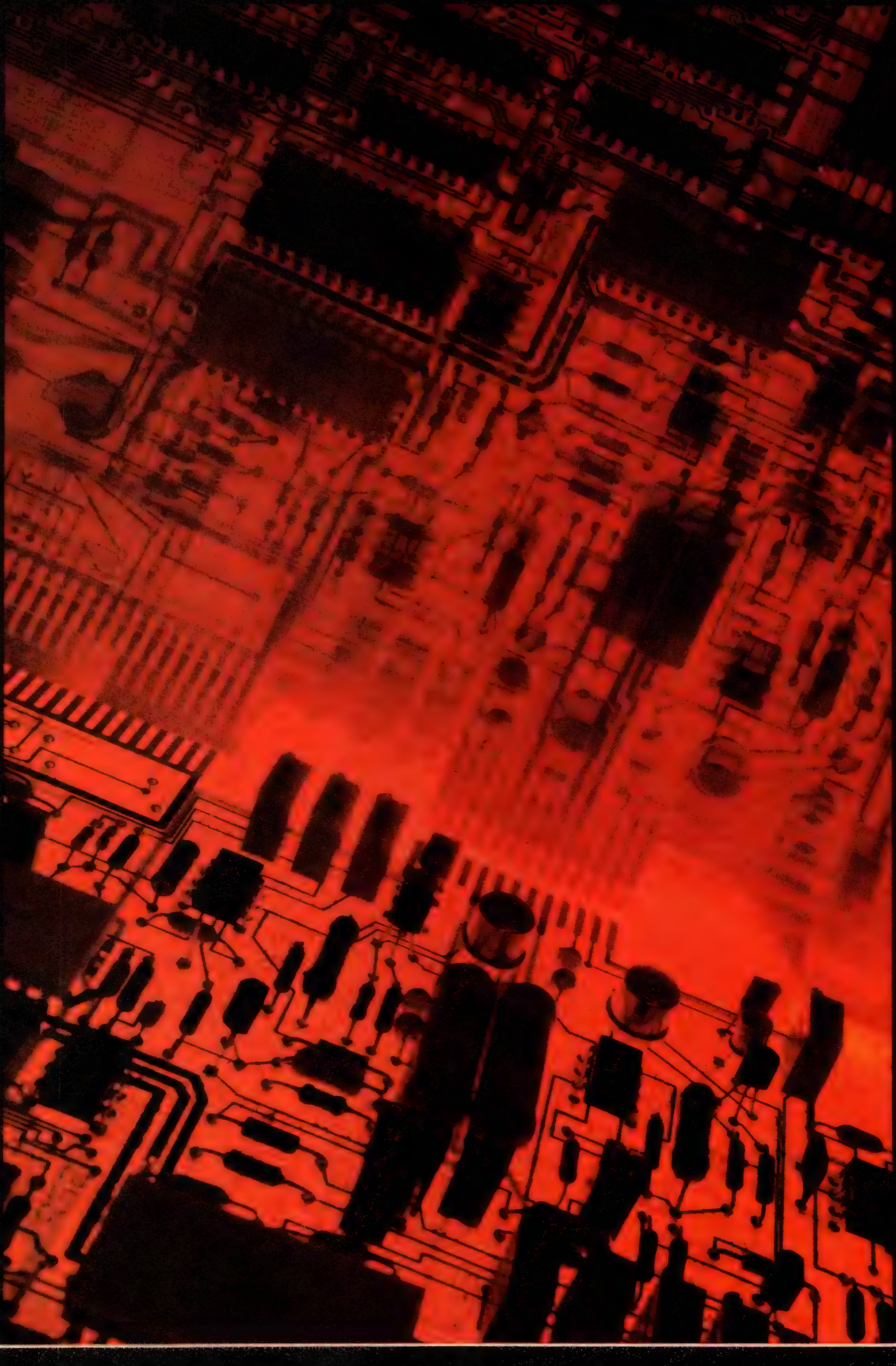


LM335—hot new linear temperature sensor.

LM359 amplifies on current amplifiers.

Dan Sowin talks about Maxi-ROMs.

Mil-temp PROMs for the masses.

Data Acquisition Logic Transistors Hybrids Linear Interface Bubble Memory
RAMs/ROMs/PROMs Transducers Displays Custom Circuits
Memory Boards Microprocessors Development Systems Microcomputers Modules

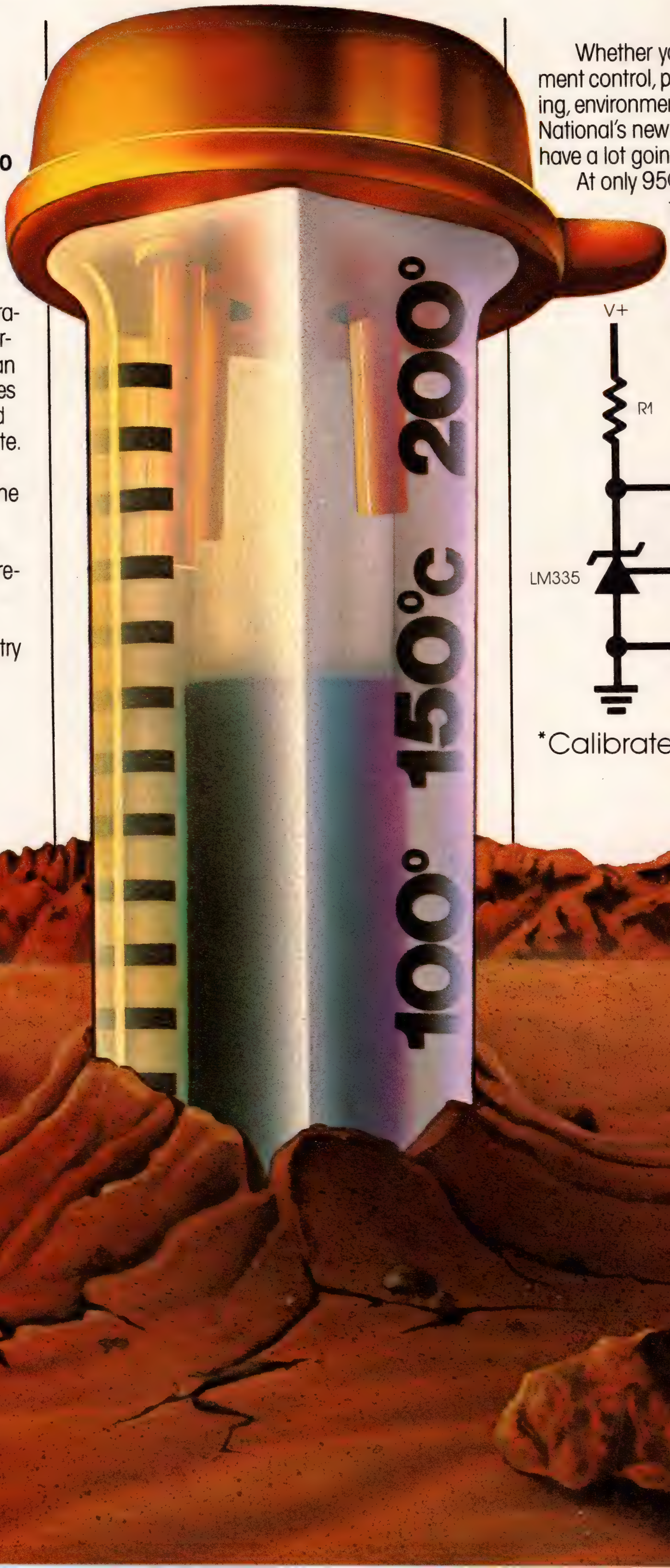
NATIONAL ANTHEM

LM335–the hot new temperature sensor that makes others obsolete.

And since it's so easy to use and costs so little, the LM335 opens a whole new world of applications that were previously too expensive or too difficult.

The LM335 is a two terminal I.C. that looks like a zener with a +10mV/K temperature coefficient. The LM335 is rated for operation over −55°C to +100°C, and has an over-range up to +200°C. Initial accuracies are available at 1°C, 3°C, 6°C; but a third lead makes the LM335 very easy to calibrate. Typically, 1°C accuracy is achieved over the entire range when it's calibrated at only one temperature.

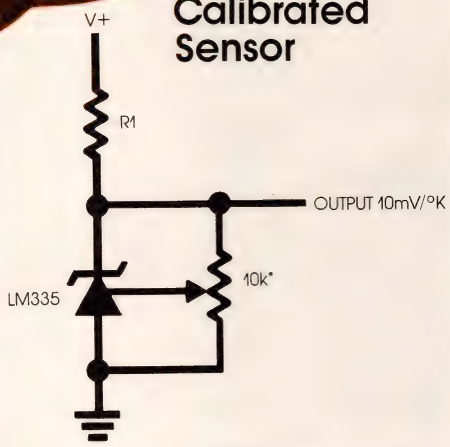
The low operating current means low error even for remote temperature measurement. Further, the LM335 eliminates the need for linearizing circuits, thus making interfacing to a readout or to control circuitry even simpler still.



Whether you're designing measurement control, protection circuitry, solar heating, environmental control or thermostats, National's new series of temperature sensors have a lot going for them.

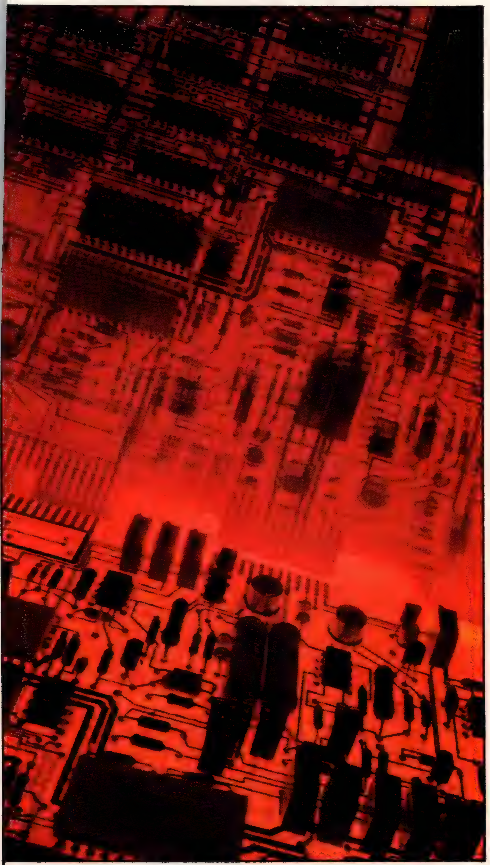
At only 95¢, it's time to start sensing temperature with I.C.'s.

Calibrated Sensor



*Calibrate for 2.982V at 25° C

New LM385 12μW micropower reference.



The lowest power reference available.

LM385 Design Features

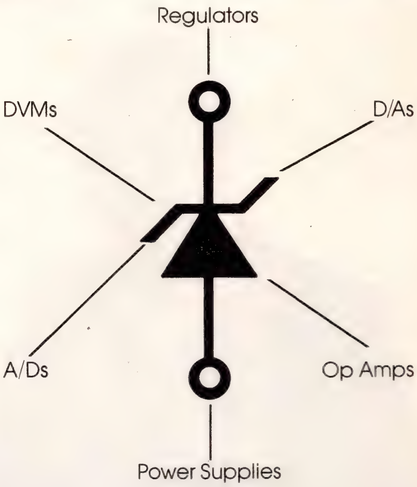
- operating current of 10μA to 20mA
- 1% and 2% initial tolerance
- low voltage reference (1.235V)
- stable under large capacitive loading
- low temperature coefficient
- low noise, good long-term stability
- 1 dynamic impedance
- replaces older devices with a tighter tolerance

The new LM385 is yet another example of National Semiconductor's commitment to supply high-performance references. Where power is a primary concern (as in battery-powered equipment, portable meters, or general-purpose analog circuitry with battery life approaching shelf life), this device provides performance unmatched by traditional discrete devices.

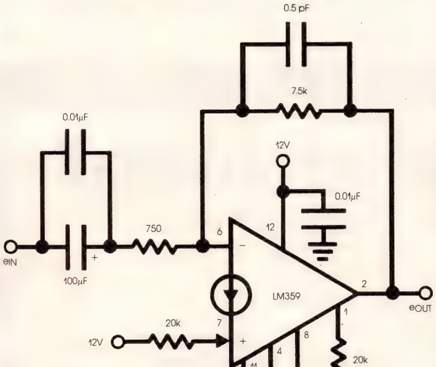
For applications requiring other reference voltages or performance specifications, National Semiconductor has the device you're looking for. For example:

V_{ref}	2.5V; 5.0V; 6.9V; 10V
Initial Tolerance	as low as .01%
$T_{C max}$	as low as 0.5 ppm/°C

Is it any wonder that more and more design engineers are looking to National Semiconductor's linear references to solve problems.



Amplifying on current amplifiers: National's new LM359.



Typical Application

When design engineers said they needed a low-cost dual that was similar to the quad LM3900, but with operation in the video frequency range, the R&D Group at National Semiconductor came up with the answer. It's the LM359 Dual, High Speed, Programmable, Current Mode Norton Amplifier.

The primary design emphasis was placed on high frequency performance and providing user-programmable amplifier operating characteristics.

Each amplifier is broadbanded to provide a high gain bandwidth product, up to 400MHz fast slew rate, 60V/μsec and stable operation. They're designed to operate from a single supply and can accommodate input common-mode voltages greater than the supply.

The LM359 solves a lot of applications problems: general purpose video amplifiers; high frequency, high Q active filters; photodiode amplifiers; wide frequency range waveform generation circuits.

Now design and application engineers have what they need, thanks to National Semiconductor.

"National is throwing its full sales and support strength behind its Static Maxi-ROM™ effort."

"When it comes to Static Maxi-ROMs, National Semiconductor is easy to do business with. In fact, the word around the industry is that National is just about the easiest company to do business with.

"It's not just that we have an outstanding line of products – 2K x 8 bits, 4K x 8 bits, and 8K x 8 bits. I think it's the fact that customers have come to realize, in ever-increasing numbers, that when they deal with National, they can order with complete confidence. All they do is submit their loaded PROM, sit back, relax, and their ROMs are delivered when they need them.

"National has a number of sales offices for customer convenience and a wealth of customer service personnel to handle orders quickly and smoothly.

"And to be quite honest about it, National is making an all-out push to dominate this marketplace. Obviously, that goes a long way toward explaining their outstanding prices, delivery schedules, and service.

"They're aggressively pursuing new business in a lot of different markets – for example, terminals, computers, home computers, mini-computers, instruments, toys and games, and word processing, to name but a few.

"So when you need Static Maxi-ROMs, call your local National Semiconductor sales office. If they can't help you, no one can."

Dan Sowin
Director of MOS/LSI

Full Mil-temp 2716 ready at National Semiconductor.

There's good news for design and applications engineers who require full military temperature range 2716s. National Semiconductor now offers the part over the full military range, for all military and industrial applications – and it's available now.

The MM2716QM is a 2K x 8 μV electronically programmable read only memory (ROM) in industry standard pin-outs, featuring a single +5V power supply and a guaranteed operating temperature range of −55°C to +125°C. Maximum access time is 450 ns.

This new National Semiconductor product is used in support of their BLCs and microprocessors. It is also programmable using Starplex.™ And it is designed and produced especially for military and extended temperature industrial systems where the extra margin of a full temperature part is needed.

The MM2716QM is functionally compatible with other existing 5V only 2K x 8 EPROMs. National Semiconductor is the first to make this product available in the full military temperature range – and it's stocked and ready for immediate shipping.

With National Semiconductor being the first to offer a full military temperature 2716, people will soon be talking about them as the source for MOS military EPROMs.

The Practical Wizards of Silicon Valley have done it again.

What's new from the National archives?

001 ☐ BLC 8737 Data Sheet
006 ☐ Special Functions Data Book ($6.00)
007 ☐ Interface Data Book ($6.00)
008 ☐ Pressure Transducer Data Book ($3.00)
009 ☐ ROM MM 52116 Data Sheet
010 ☐ ROM MM 52132 Data Sheet
011 ☐ ROM MM 52164 Data Sheet
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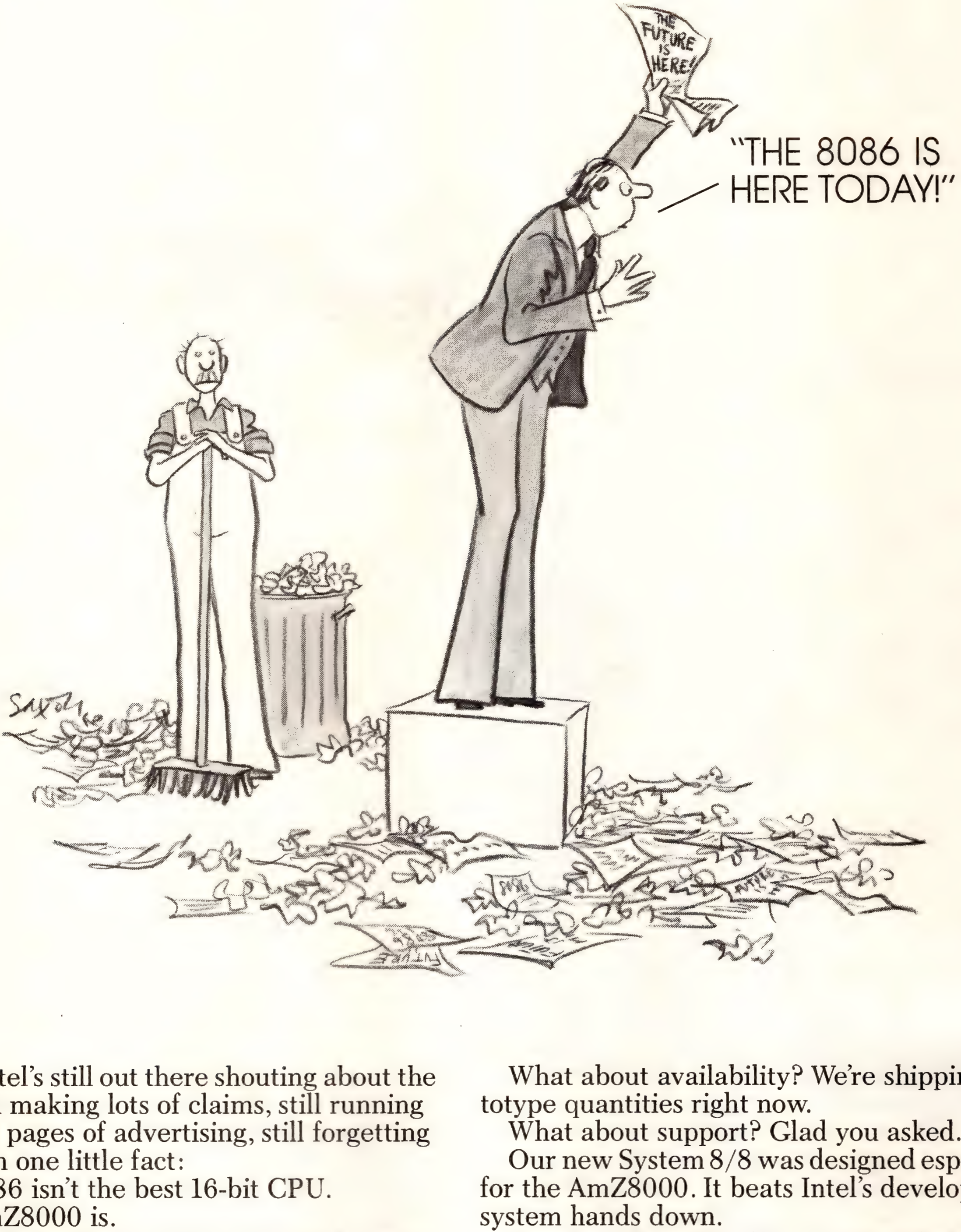
CIRCLE NUMBER 65

10
ELECTRONIC DESIGN
1980 TOP TEN ADVERTISERS


THE FUTURE IS HERE!
"THE 8086 IS HERE TODAY!"
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FUTURE

Well, Intel's still out there shouting about the 8086. Still making lots of claims, still running pages and pages of advertising, still forgetting to mention one little fact:

The 8086 isn't the best 16-bit CPU.

The AmZ8000 is.

The AmZ8000 has a more advanced, more powerful, much more flexible architecture than the 8086. It has more addressing modes, more general purpose registers, more powerful instructions. It can even accommodate more data types. It has better I/O capability, larger addressing spaces, and a lot higher throughput using standard NMOS, than the 8086 using HMOS.

What about availability? We're shipping prototype quantities right now.

What about support? Glad you asked.

Our new System 8/8 was designed especially for the AmZ8000. It beats Intel's development system hands down.

System 8/8 can be directly upgraded to a 16-bit system by changing one card. Intel's can't. System 8/8 can translate 8080/8085 and Z80 programs. Intel's can't. System 8/8 has a PASCAL compiler that produces object code for the 8080 and AmZ8000. Intel's doesn't. System 8/8 comes with 8080/8085, Z80, and AmZ8000 macroassemblers. Intel's doesn't. System 8/8's in-circuit emulators include, in

"So is the AmZ8000.
And it's better."
Saxon

addition to the AmZ8000, the 8080, 8085, 8048, and the Z80. Intel's doesn't. And we let you buy our System unbundled.

To demonstrate the capability of the AmZ8000 we developed a fully assembled and tested Evaluation Board. It's got the AmZ8002 CPU on it, along with RAM, EPROM, and I/O. It plugs right into System 8/8 and can execute the assembler or PASCAL object code. Ask for it by name: AMC96/4016.

Just one more thing: We know it hurts to drop Intel for somebody else. We've been through it ourselves. But it's going to hurt a lot more next year. By then your competitors could be so far ahead of you, you might never catch up.

Call Advanced Micro Devices and we'll send you everything we've got on the AmZ8000. Or come to one of our seminars. Or sign up for a course on the AmZ8000.

Better yet, buy an AmZ8000. Check it out for yourself. Put it through its paces. Compare it with the 8086.

Intel can beat their chests all they want.
But they can't beat the AmZ8000.

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CIRCLE NUMBER 66

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10
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Sorry Doc. It's custom MOS/LSI.

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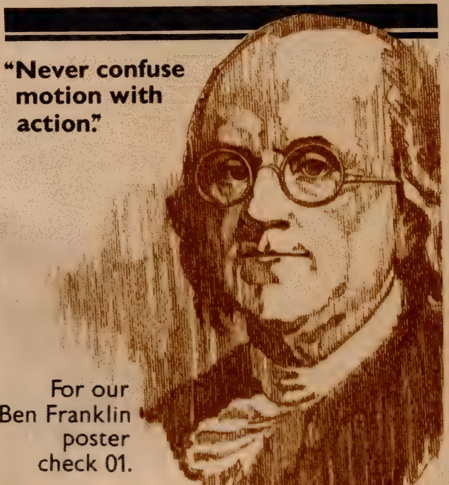
CIRCLE NUMBER 67

INTERSIL INSIGHT

1

THIS IS THE FIRST ISSUE OF THE NEW INTERSIL INSIGHT.

We think you'll find it's the last word in what's new and important in linear integrated circuits, memory and microprocessor systems, data acquisition systems, power MOS devices, display drivers and more. Whenever you see an item that catches your interest, just check the appropriate number on the coupon on the back page for more product data. We call it the *You Got Me!* coupon. Be sure to check it, clip it, and send it in. Because at Intersil, we have answers.


"Never confuse motion with action."

For our Ben Franklin poster check 01.

CMOS EPROM Programmer Operates Stand Alone or with Terminal.

Our microprocessor-controlled Model 6920 CMOS EPROM programmer is designed for use with the IM87C48/C41 single chip microcomputers and IM6653 (1K x 4) and IM6654 (512 x 8) CMOS EPROMs. And there are provisions for up to three additional types of CMOS EPROMs provided in the hardware. The 6920 operates with a terminal, as a stand-alone unit, or as a peripheral to a computer. It features built-in RS232C and 20mA current loop interfaces. And 14 different baud rates from 50 to 9600 can be selected. Check 02 for more on the 6920.

Monolithic 4-Digit Up/Down Counter Directly Drives LEDs Up to 1" High.

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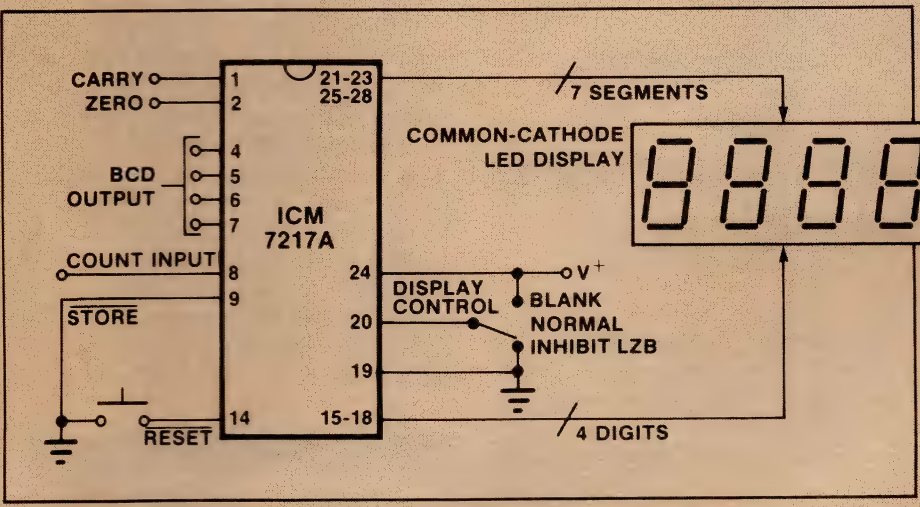
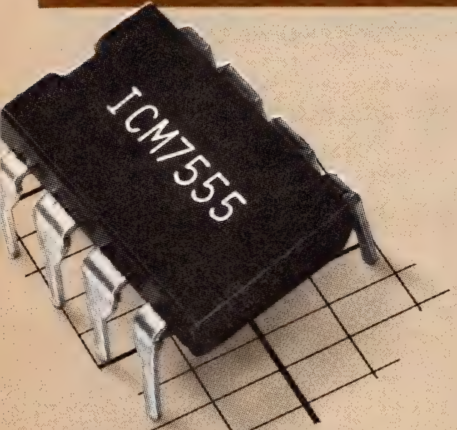
The ICM7217/27 family of 4-digit up/down counters will directly drive large multiplexed 7-segment LED displays. Either common anode or common cathode. The common anode devices typically drive 200mA per digit, 40mA per segment peak for bright displays. Or, go common cathode and use a calculator type display for lower power and display costs. Either way, forget external drivers or resistors. Features include: Presettable up/down counter and register. BCD inputs/outputs that drive TTL directly. Leading zero and display blanking. Low power standby mode—300μA typical with display off. Cascadable: 8 or more digits in blocks of four. Counting speed guaranteed to 2MHz. Single ±5V 10% supply. Check 03.





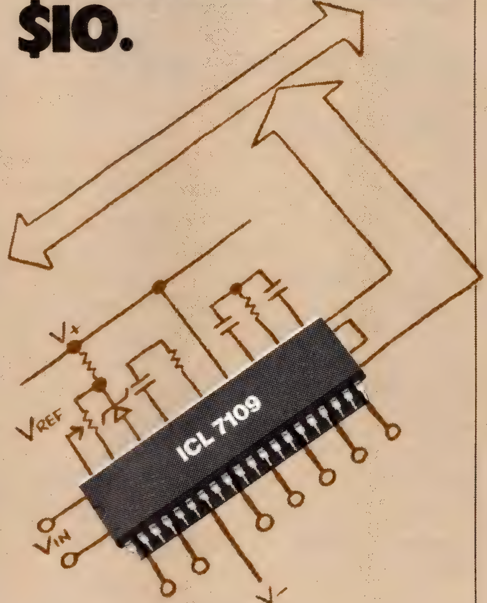
CMOS TIMERS.

Here's a new high-performance equivalent to the classic 555 RC timer. The ICM7555 general purpose timer features a typical power supply current rating of only 80μA. That's less than 1/20th required by its bipolar counterpart. We guarantee an expanded high speed operation to 500KHz. That's a five times improvement over the industry standard 555! The new Intersil units last longer, use less current and have a widened supply voltage range of 2 to 18V. Ideal for applications impossible with the old 4.5V bipolar 555's. Check 04 on the *You Got Me!* coupon.

Designed for Designers. 5μV V_{OS} Instrumentation Amplifiers.

A monolithic instrumentation amplifier with a unique commutating auto-zero design circuit principle. The ICL7605. While one op amp is in a signal processing mode, a companion device is switched into an error-null configuration. The result: lower cost and better performance. With near-zero offset voltage temperature drift of only 0.05 μV/°C. Long-term input offset drift of 0.2 μV/year. Open loop gain of greater than 105dB. 5pA input leakage current. And common mode rejection ratio (CMRR) of 110dB. CMOS construction fits low power requirements. It's the best low drift instrument amplifier that you can buy. And it only costs $15 in lots of 100. Check number 05 on our *You Got Me!* coupon.

12-BIT A/D CONVERTER: $10.



Here's the first ±12-bit monolithic A/D converter chip targeted for a wide variety of microprocessor applications, with a $10 price tag in 100 unit quantities. The CMOS ICL7109 features a three-state output that can be directly interfaced to the data buses of microprocessors such as the Intersil 6100 or IM87C48, the Motorola MC6800 and the Intel 8080 and 8048. And it can be used for remote serial data logging applications. Just check 06 on the *You Got Me!* coupon for more info.

$I_{D(ON)} \times R_{DS(ON)} = \text{Error}$

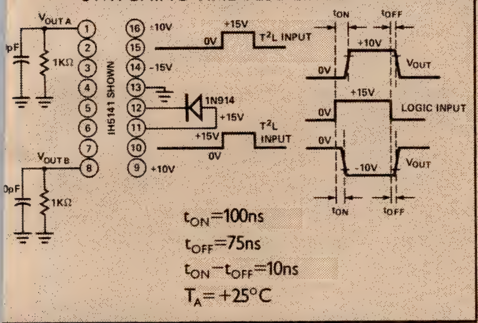
Lowest Error MUX's.

New Intersil IH6116/IH6108 multiplexers are pin-for-pin replacements for the industry standard 16 and 8 channel MUX's you're probably using now. But, they offer the low power, low error performance of Intersil's latch-up proof CMOS process. They draw a maximum supply current of 0.2mA. And they consume only about 1/10 the power of their nearest competitor: 4.5mW Max., at ±15V. That means virtually no self-heating... leakage current of 0.2 nA @ 25° doesn't change as the device "warms up." You get the lowest power consumption and lowest leakage in the business. Just check 07 on the coupon.

HIGHEST SPEED, LOWEST POWER ANALOG SWITCHES ON THE MARKET.

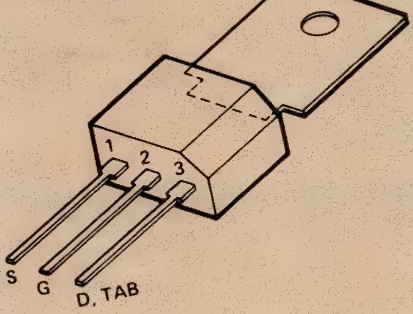
t_{ON}80ns typical and t_{OFF}50ns typically characterize the ultra-fast switching times of the IH5140/IH5145. In fact, they're the fastest switches available! (They toggle at better than 1MHz.) And they combine the speed of the hybrid DG180 family with the inherent reliability and low power consumption of CMOS construction. The new switches are available in single or dual SPST, SPDT, or DPDT functions and feature power supply currents of less than 10μA Max. Check 08. And be sure to check into our entire family of analog switches. From monolithics to hybrids, Intersil has the answers.

SWITCHING TIME TEST CIRCUIT



t_{ON}=100ns
t_{OFF}=75ns
$t_{ON}-t_{OFF}$=10ns
T_A=+25°C

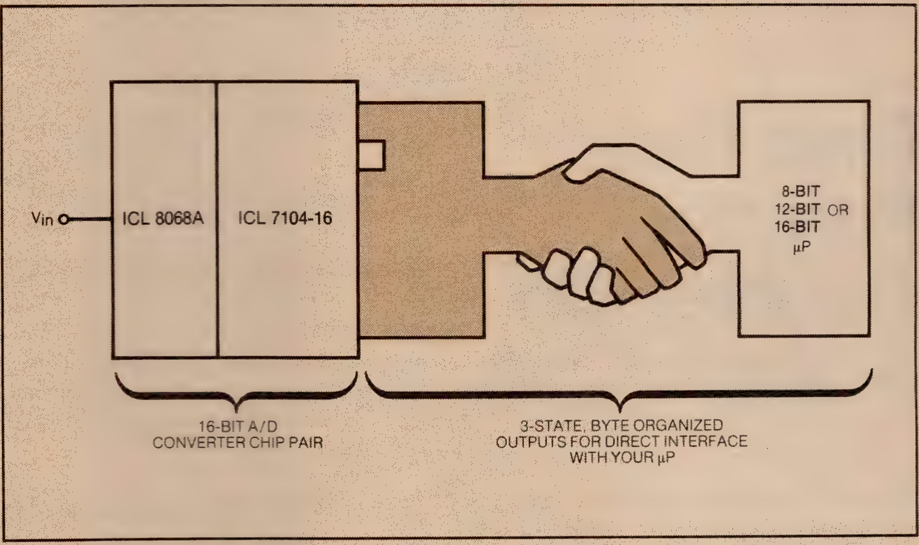
POWER MOS.



You get more efficient operation and fully characterized maximum ratings in our new IVN5200 family of VMOS power FETs: 80V BV_{DSS}. 5A $I_{D(ON)}$. 0.5Ω$R_{DS(ON)}$ Max. Ideal for high frequency switching power supplies, servo amplifiers, motor controls, high level analog switches...you name it. And the IVN5000 series of 2.5Ω to 4.0Ω devices. IVN-5000 specs: 80V BV_{DSS}. 2.5Ω$R_{DS(ON)}$ Max. Choice of packages including TO-52 and TO-237. Great in applications such as peripheral interfaces and RF amplifiers. Plus, an alternate source for the Siliconix VN series. Check 09.

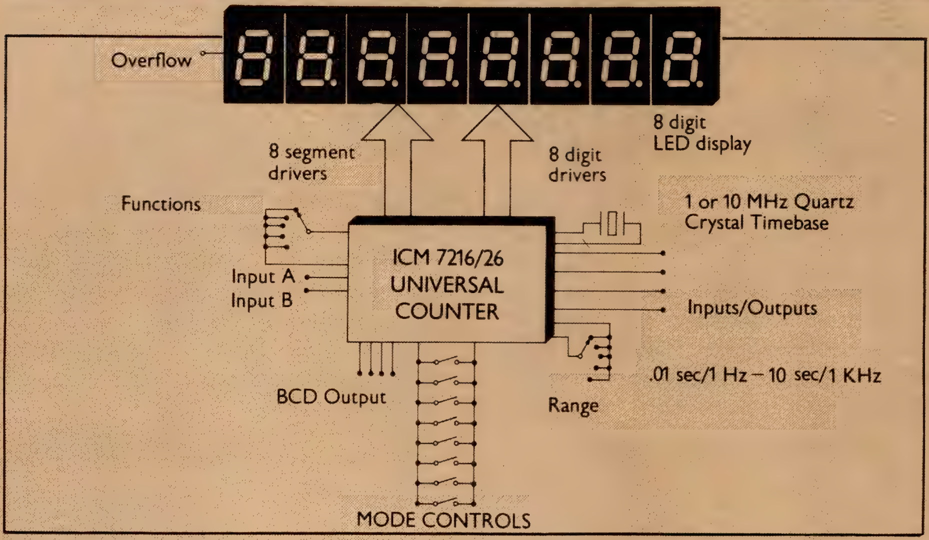
A CMOS 16-BIT IC A/D CONVERTER: $29.

First again! A true 16-bit A/D converter in IC form. It's called the ICL7104/8068 chip pair, and it's specifically intended for microprocessors. Its interface capability allows it to be used with virtually all microprocessor systems with buses up to 18 bits wide. And the high performance, low noise A/D chip set will operate in either close-in parallel or handshake modes. There's more. 16-bit binary resolution is 1 part in 65,536. Maximum non-linearity is 1 count over ± full scale. Resolution ‹10 μV per count. Voltage noise ≈2 μV. True auto zero. Zero drift 0.5 μV/°C. Full-scale Tempco 2ppm/°C (ext. ref.). Ratiometric operation. Direct interface to any μP or UART. Check 10.



LOWEST VOLTAGE IN THE INDUSTRY WITH CMOS OP AMP FAMILY.

Here's a unique approach to circuits where ultra-low input current and minimum power consumption are essential parameters. The new ICL7611 family of CMOS Op Amps. Low voltage operation is guaranteed at ±0.5V (the lowest in the industry) to ±8.0V, while providing output swings to within a few millivolts of the supply voltage rails. And they're capable of single-ended operation from a single NiCd battery. A novel quiescent current selection pin allows the user to program currents of 1mA, 100μA or 10μA, without external components. That means a power drain as low as 10 μW. Input currents of 1pA are 30 times lower than those of BiFETs. And the other parameters are just as impressive. The ICL7611 family devices are available as singles, duals, triples, and quads in internally-compensated or uncompensated configurations. For the rest of the specs on the lowest voltage op amps in the industry, check 11.



First Five-Function Counter On A Single Chip.

The ICM7216 Universal Counter IC contains the functions of a frequency ratio counter, period counter, unit event counter, frequency counter and time interval counter all in one. It operates off a single ±5V supply, can function at frequencies up to 10MHz, has eight-digit multiplexed LED displays capable of switching up to 250mA per digit, typically. The ICM7216 Universal Counter IC will directly drive both digits and segments of large LED displays. From $16.65 in 100 unit quantities. Check 12.

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VOL. I

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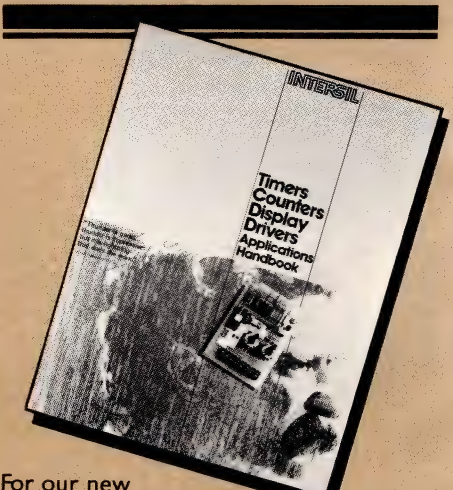
Hot New Lit.

Low Cost Digital Panel Meter Design (#A023). This "how to" piece gives a full run-down on ICL7116/7117 3½ digit A/D converters with display hold. Also tells about the two evaluation kits you can get. For more information check 13 on the coupon.

The ICL7104: A 16-Bit Binary A/D Converter for Microprocessors (#A030). A handy app note if you're interfacing with UARTs, microprocessors or other complex circuitry. Includes descriptions of handshake mode, buffer gain, auto-zero, external zero and detail on auto-zero loop residual errors. Check coupon 14.

CMOS: Higher Speeds, More Drive and Analog Capability Expand Its Horizons. An important 10-page article reprinted from *Electronic Design* magazine. It's a real eye-opener for anyone who still thinks CMOS must be confined to the slow world of 100KHz digital logic. Check 15 on the coupon.



For our new
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Joan Borst is doing 5 to 10 on a bum wrap.

Joan should've talked to Garry. Instead of condemning her to a faulty wire wrap,* we'd have given her a complete selection of quality services and products.

She could have bought our wire wrapping* (the best in the industry). She could have bought our boards, our headers, our racks, or the complete package. From LSI adapter boards through microprocessors to ECL logic boards, from 8 pin header sockets to LED display sockets.

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CIRCLE NUMBER 69

Presenting the first 6 megabyte floppy drive!

Now get 6 megabytes of memory in about the same space as a 1 megabyte drive.

That's right. Until now, the only way you could build up to 6 megabytes of floppy disk memory into your product was to add on drive after drive.

The new Burroughs MD122 memory unit drives two 8-inch, double-sided floppies, each with a formatted capacity of 3 megabytes.

Now you can do all these applications that require more capacity, yet keep the advantages of low cost, removable media. And your system's performance will improve, too, due to the MD122's voice coil actuator with a 100 ms average access time.

We've already built in an Advanced Microprocessor Controller (AMC) which performs many of the functions normally required of the host system controller and the host CPU.

We've already interfaced it!

- CRC generation
- Error detect/correct
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- Media wear monitoring and warning to host

Now you can expand your memory and save on space and cost. Call or write today for our low evaluation unit price and complete specifications.

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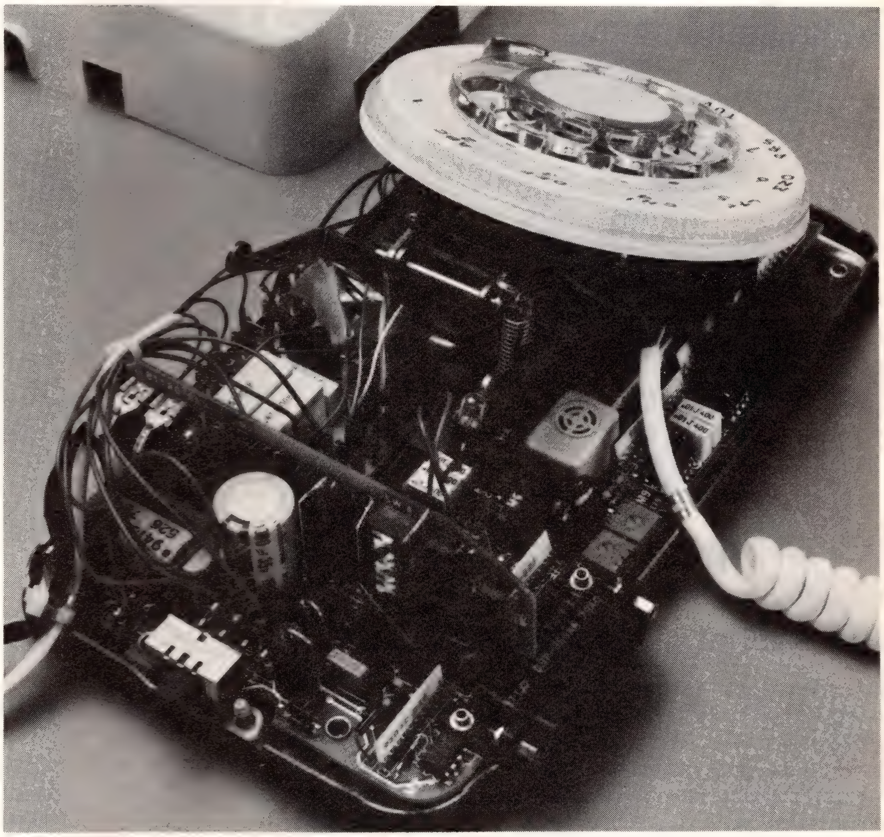
CIRCLE NUMBER 70
CIRCLE NUMBER 71

Modem-and-telephone-in-one simplifies data-comm setups



Racal-Vadic, 222 Caspian Dr., Sunnyvale, CA 94086. (408) 744-0810. P&A: See text.

The VA103 ModemPhone combines a full-duplex Bell 103/113-compatible modem for direct-connect originate/answer with a standard telephone to yield a compact device that performs functions previously requiring two separate instruments. A user simply plugs the ModemPhone into a standard telephone-company voice jack (RJ11C) or programmable data jack (RJ41S or 45C), connects a data terminal and starts communicating.

With data terminals becoming standard desktop equipment in offices, plants and homes, eliminating a separate modem box makes a smaller, more attractive installation. Also eliminated is the need to rent a separate telephone instrument for use with a modem, which should prove a substantial cost saver.

ModemPhone provides both voice and 0 to 300-bit/s, full-duplex data communications. A standard ITT rotary or tone telephone is used, with all modem circuitry mounted on a 17.5-in.^{2} PC board inside the case. The modem itself is custom-designed and miniaturized to fit within the telephone. In addition, the phone's bell has been replaced with a solid-state buzzer to allow room for the modem board.

Voice, originate or answer modes of operation can be selected via a three-position slide switch on the ModemPhone's handset. In addition, the unit is equipped with an 8-ft cable and plug for connection to telephone-company lines. A 25-pin connector on the instrument accepts an RS-232C interface from a terminal. A visual carrier-detect indication is supplemented by a ringing sound.

ModemPhone directly replaces Bell 103A/103J and 113A, B, C and D modems. A manual model can be factory-upgraded to an automatic version. In addition to operator-controlled originate/answer, the option offers such features as loss-of-carrier and abort-timer disconnects. And while DSR is forced on in the manual answer or originate modes, with the automatic option, DSR follows Carrier Detect, Automatic Answer in Voice Position and Force Data Terminal Ready On.

Four basic ModemPhones can be ordered with rotary dial or tone keyboards. All models have TTY (20-mA current loop) capability using a Racal-Vadic 880 adapter. A UL-listed power supply is built-in, and a standard white telephone instrument is supplied. However, on volume orders, special colors are available.

ModemPhone costs $250 in single quantities and less for larger orders. The automatic originate/answer option is offered for an additional $80. Delivery takes eight weeks after receipt of order.

CIRCLE NO. 301

Harold Winard
New Products Editor

Grayhill DIP switches Now available totally sealed

including a sealed base without price premium

Maximum seal integrity
Each Grayhill SPST DIP switch now is potted as part of the assembly process, to provide a more professional and economical bottom seal. Flux entry during wave soldering is totally prevented; contamination is eliminated; reliability is enhanced; and prices are unchanged... there is no cost premium for this improved performance.

Top-side sealing, too
Grayhill offers 3 options, for raised or recessed rockers—a tape seal, applied at Grayhill; cards of tape seals, for your application; or re-usable protective covers.

Available off-the-shelf
Grayhill SPST Sealed Base Rocker DIP Switches, with from 2 to 10 rockers, are available off-the-shelf, from Grayhill or its nationwide distributor network.

Ask for free DIP Switch Catalog.

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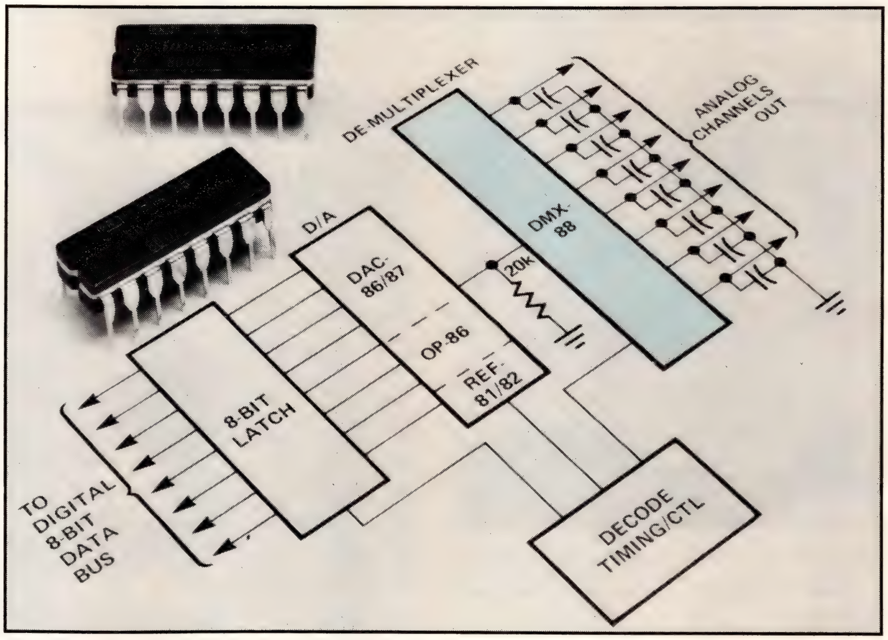
CIRCLE NUMBER 73

Demultiplexer holds down idle channel noise



Precision Monolithics, Inc., 1500 Space Park Dr., Santa Clara, CA 95050. (408) 246-9222. P&A: See text.

Instead of getting an analog multiplexer to operate in reverse as a demultiplexer—something most multiplexers are not optimized to do—a better alternative is to start out with a device designed specifically to demultiplex. And that's what the DMX-88 is designed specifically to do.

The analog switches of the 8-channel DMX-88 are designed to keep the charge injection on the demultiplexed outputs to no more than 25 pC and to 18 pC, typically. As a result, the DMX-88 can be used in shared-channel PCM decoder applications, where idle-channel noise must be kept as low as possible.

Fabricated from PMI's BIFET technology, the DMX-88 uses JFET switches and maintains a low, constant on-resistance—typically 290 Ω. In addition, it does not suffer from the latch-up or static charge blow-out problems plaguing CMOS parts. Furthermore, CMOS devices, when used in reverse, inject a much larger charge into the output amplifiers than BIFET devices do and thus cause much larger offsets and apparent channel noise at the outputs.

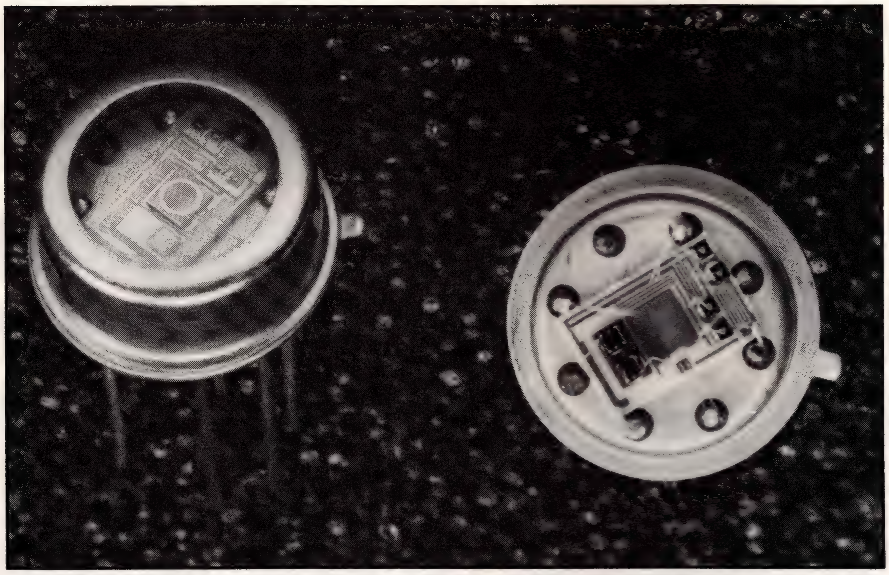
Basically, the DMX-88 has the same pinout as the PMI MUX-88 multiplexer. Housed in a 16-pin hermetic DIP, the demultiplexer comes in two versions: the high-speed DMX-88E (400-Ω max on-resistance) and the low-power DMX-88F (520-Ω max). Requiring no pull-up resistors to operate in a break-before-make fashion, the eight-channel unit has a typical break-before-make delay of just 1 μs. It also has an output settling time of 1.7 μs for a 10-V step (the F version) and a range of 1.3 to 2.3 μs, depending on the settling tolerance—0.1% to 0.02%, respectively (the E version). Typical crosstalk isolation at a frequency of 20 kHz is kept to 96 dB, typically, while the off isolation is typically 88 dB.

The E version typically switches in just 1 μs, and requires at most 300 mW. The F version switches in 1.5 μs and requires 225 mW. Both operate over −25 to +85 C and require ±15-V supplies.

In 100-qty lots, the DMX-88F costs $6.75; the DMX-88E, $7.85. Delivery is from stock.

CIRCLE NO. 302

Hybrid optoreceiver gives broad bandwidth, low noise



Meret, Inc., 1815-24th St., Santa Monica, CA 90404. John Keating (213) 828-7496. P&A: See text.

An optical receiver, constructed on one specially designed hybrid substrate and housed in an open TO-5 metal can, provides an unusually broad bandwidth along with high sensitivity and extra protection from shock and vibration for low cost. Developed by Meret and introduced at the Nepcon West Packaging show in Anaheim, CA, the R-1900 optical receiver is well-suited to open-air as well as fiber-optic transmissions.

The total rms noise of the R-1900 is less than 100 μV over the entire bandwidth of the device, which is 100 MHz. The noise-equivalent power of the optical receiver is 2×10^{-12} W/$\sqrt{\text{Hz}}$. Not only that, but the noise voltage approaches the theoretical limit of the Johnson noise in the internal feedback resistor of the transimpedance amplifier.

Responsivity in the receiver is 0.6 μA/μW for the p-i-n photodiode detector, 2 mV/μA for the transimpedance amplifier, and 1 mW/μW for the complete receiver package. The R-1900 is so sensitive that it will respond to signals from a penlight flashed across a 15-ft room, as well as to a number of other open-air optical transmissions within the 400 to 1100-nm wavelength.

Constructing the R-1900 on one hybrid substrate makes the Meret optical receiver much more reliable than similar devices. Optical receivers with the sensitivity of the R-1900 normally incorporates two substrates inside the TO-5 package. The problem is, in addition to increasing the source of current noise in the receiver package, a two-substrate design frequently strains the interconnections between substrates. The single-substrate design, in contrast, will not add strain to connections between diode and amplifier chips.

The R-1900 is an extension of Meret's movement toward integration that began with the company's R-1000 optical-receiver package. Like the R-1900, the R-1000 now employs a single substrate design. It differs from the R-1900, however, in offering a much higher—300 times higher—gain, but at the expense of bandwidth and noise.

The responsivity of the R-1000 diode is 0.6 μA/μW, 600 mV/μA for the transimpedance amp, and 300 mV/μW for the entire receiver package. The bandwidth, however, is limited to 0.25 MHz. The rms noise is 150 μV over the bandwidth and the noise-equivalent power is 6×10^{-13} W/$\sqrt{\text{Hz}}$.

The R-1900 optical receiver costs $99 in quantities of ten; the R-1000, $71. Delivery for both is from stock to six weeks.

CIRCLE NO. 316

VACTEC
CdS/CdSe
LIGHT
DEPENDENT
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VACTEC LDR'S are photoconductive cells responding to visible light by proportional resistance change. A typical cell such as the VT833 will be >10MΩ under moonlight illumination and <1.0KΩ in room light. Their small size, low cost, and spectral range of 400-700nm makes LDR's an excellent ambient light sensor for day/night threshold controls, automatic brightness controls for CRT terminals, TV sets, digital clocks, automotive, and aircraft instrument displays. Apply them as any variable resistance.

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CIRCLE NUMBER 72

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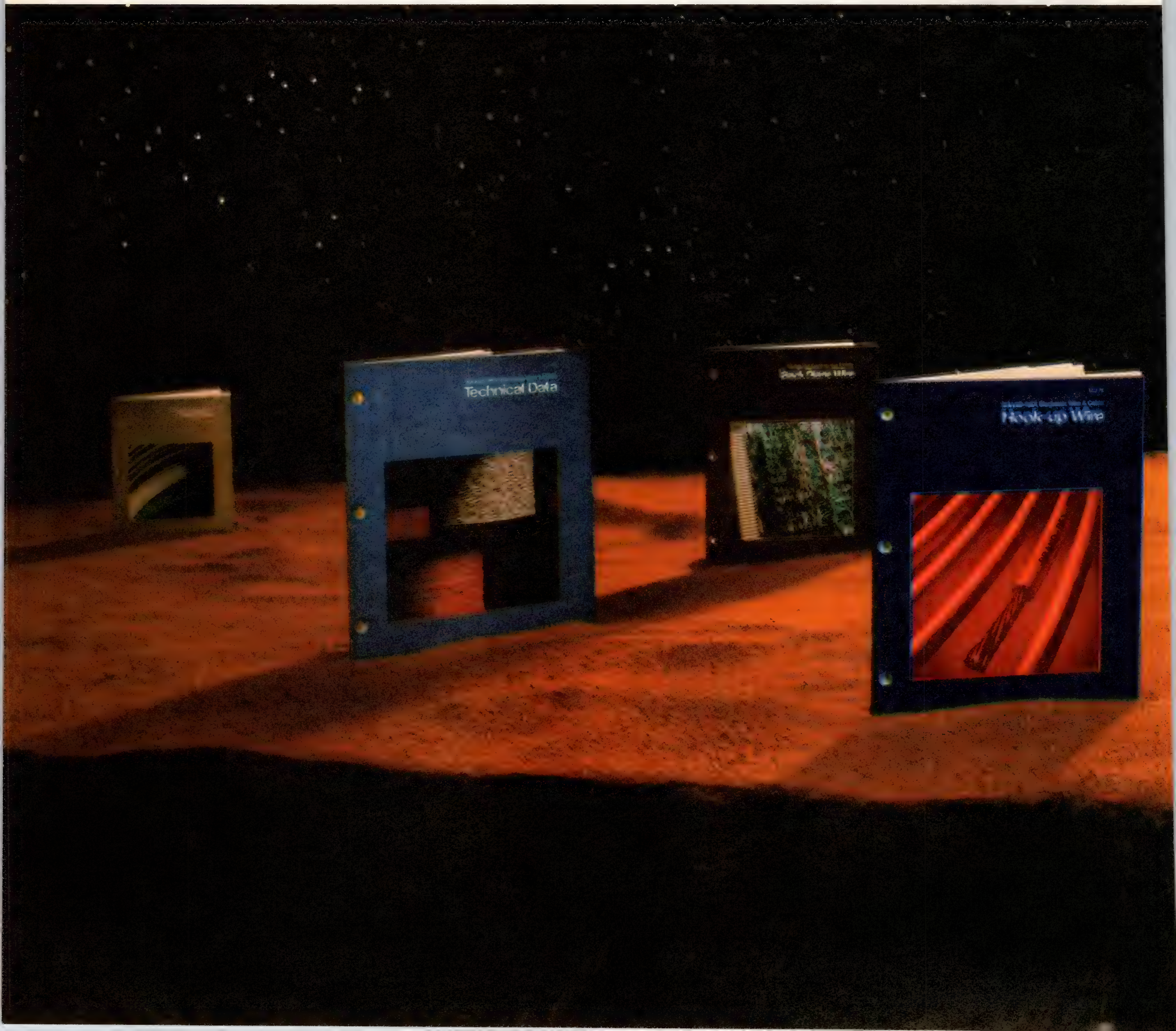

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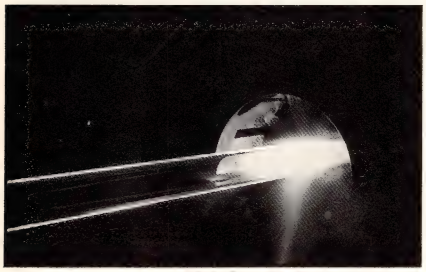
CIRCLE NUMBER 167

Double-window fiber handles both 850 and 1300 nm



Vapor-phase oxidation is just one of the steps used in the manufacture of double-window fibers.

Corning Glass Works, Telecommunications Products Dept., Corning, NY 14830. P&A: See text.

The Corguide 3008D, an all-glass double-window fiber with a cellulose-acetate lacquer coating, provides very low signal attenuation at both 850 nm (first window) and 1300 nm (second window) wavelengths. Attenuation at the first window is less than 3.0 dB/km, while attenuation at the second window is 1.5 dB/km.

Actually, the fibers are optimized for both attenuation and bandwidth. While the attenuation is highest at 850 nm and lowest at 1300 nm, the widest bandwidth is near 1000 nm.

Currently, 850 nm is the most popular design wavelength for short-run telecommunications. For long-term usefulness, Corning engineers have anticipated second-generation fiber optic system requirements; the second window conductance is tuned for a wavelength which is pegged for future long-range transmissions.

Minimum bandwidth in either window is 800 MHz-km. The Corguide 3008D has an outer diameter of 125 μm, and is 50 μm in diameter at the core.

Intended for cross-continental transmissions, the double-window fibers are available in 1100-m lengths on reels. The Corguide 3008D is $1.40 per meter in 100-km lots. Delivery time is four weeks.

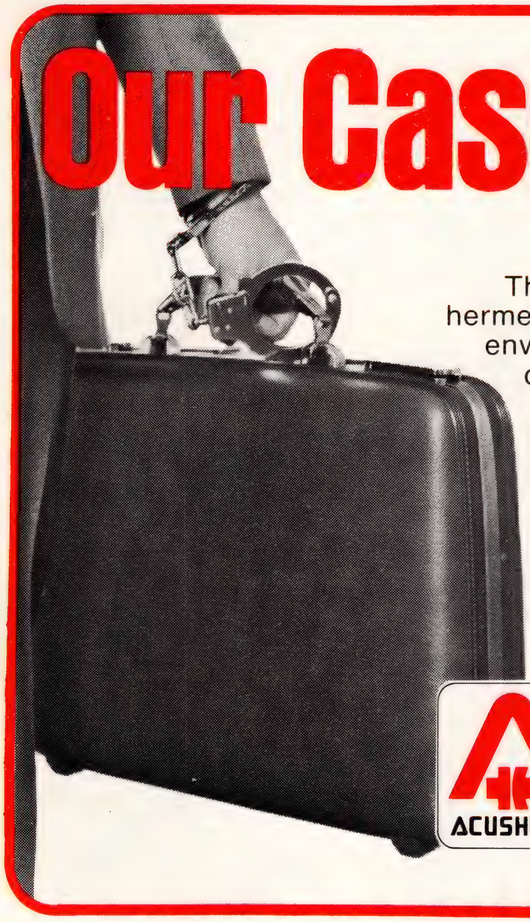
CIRCLE NO. 304

Power amp modules boost cellular radio signals

Motorola Semiconductor Products, P.O. Box 20912, Phoenix, AZ 85036. Alan Wagstaffe (602) 244-6394. $41 (MHW808); $58 (MHW820) (100 qty); stock.

Hybrid power amplifiers, MHW808 and MHW820, boost signals in the 800-MHz conventional and cellular mobile radio bands. MHW820 uses three common-emitter amplifier stages for a minimum gain of 19 dB and a 20-W power output. For full output power, input power is 250 mW maximum. Harmonic distortion is at least −58 dB below the carrier. MHW808 has two cascaded stages producing 7.5-W output power, minimum gain of 14.8 dB and a maximum harmonic output of −52 dBc. The modules use a copper heatsink and a beryllium-oxide substrate material for good thermal conductivity. Circuit conductors are gold. Input and output impedances are matched to 50-Ω systems. A 30:1 VSWR will not damage the output state regardless of phase angle. Each module works as an output stage or a driver. Supply voltage range is 10 to 16 V.

CIRCLE NO. 460



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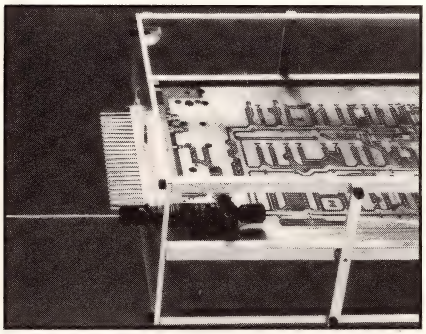
CIRCLE NUMBER 75

Connectors speed up terminations of fiber-optic cables with low loss



The Deutsch Co., Municipal Airport, Banning, CA 92220. Mike Hands (714) 849-7822. P&A: See text.

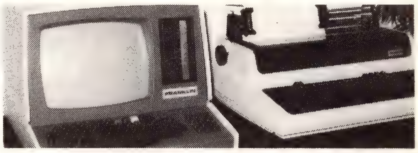
A new fiber-optic connector makes field terminations rapidly, with insertion losses of less than 1.0 dB. The Radiant Lens Card Connector consists of a DW4300 plug and a DW4200 receptacle. In handling fibers with core diameters of 50 to 100 μm, the spring-loaded connector presses the fiber ends into a low-loss optical lens. A variety of shells accommodates the different types and thicknesses of optical fibers.

In addition, the Deutsch production line includes a precision hand-held scribe-and-break tool. For use with the Deutsch Optical Waveguide connectors, the tool makes a smooth break in one operation. First, the fiber is stripped and inserted in the connector cap, and the cap is screwed onto the cutting tool. One operation completes the scribe-and-break procedure which not only leaves a smooth end, but also the appropriate length of exposed fiber in the connector cap, ready for insertion into the optical lense. The connectors can be mounted directly on boards.

In very small lots, the DW4200 series receptacle costs $28.31, while the DW4300 plug costs $42.47. Delivery is typically within eight weeks.

CIRCLE NO. 320

Processing system speeds message handling



Franklin Systems, 733 Lakefield Rd., Westlake Village, CA 91361. (805) 497-7755. $7850.

An electronic processing system, TC/2, speeds message handling and transmission over TLX, TWX, DDD or private lines. A complete message, word and data processor, TC/2 communicates in ASCII or Baudot code at user selectable baud rates. The system includes a CRT/keyboard entry station with dual Z80 processors, 48-k dynamic buffer, a 100-k minidisk drive, DOS software and a 30 char/s matrix printer. Full text editing capabilities are provided. TC/2 automatically accesses the correct communications line, dials a desired number (retrying if the number is busy), verifies the answerback, transmits a message and prints the full text on the system printer, inserting the date and time the message was sent.

CIRCLE NO. 339

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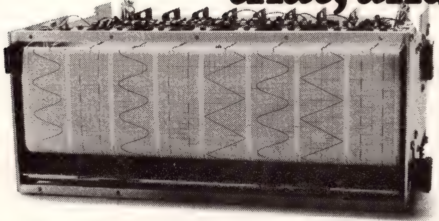

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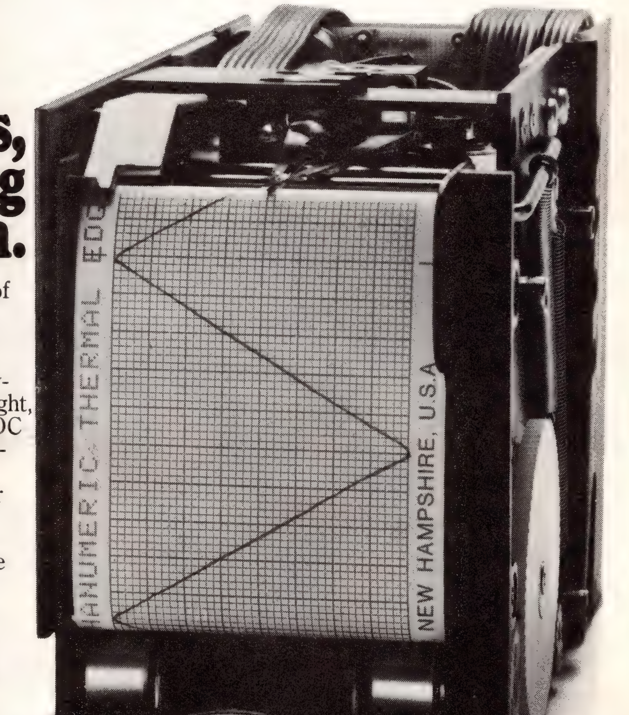
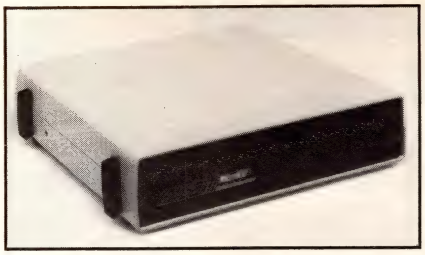


Our new DC module. (Seen here actual size.)

CIRCLE NUMBER 76

Multidrop data multiplexer works well beyond FDM-system rates



Micom Systems, 9551 Irondale Ave., Chatsworth, CA 91311. (213) 882-6890. P&A: $1250 to $4800; 8 wks.

Micro900, a statistical multiplexer from Micom Systems, ties up to 16 data terminals at eight separate locations to a single telephone line—without the speed restrictions found in frequency-division-multiplexing systems. A multidrop concentrator, Micro900 allows terminals to operate at virtually any asynchronous data rate to 9600 bits/s, far in excess of the 1200-bits/s maximum found in FDM systems.

Micro900 should help the minicomputer operator working with teletypewriter-compatible CRT and printing terminals with no built-in error control. The concentrator requires no special polling software and no changes to existing hardware or software. It also provides automatic retransmission-on-error to assure error-free communications on a multidropped telephone line.

While borrowing circuitry from its predecessor, the Micro800, the Micro900 goes well beyond it. Unlike the Micro800, which links a cluster of terminals in one regional office using a single point-to-point telephone line, the Micro900 system links up to eight regional offices with a central computer—all with only a single, multipoint telephone line. Use of a multipoint line results in substantial savings in a system now using point-to-point lines.

Micro900 supports computers and terminals from various manufacturers, including DEC, Data General and Hewlett-Packard. Installation is simple and can be accomplished by untrained personnel. Built-in self-test features facilitate installation and troubleshooting in the field.

CIRCLE NO. 305

SAW filters replace L-C, crystal types

Rockwell International, 4311 Jamboree Rd., Newport Beach, CA 92660. (714) 833-4324. Under $150 (70 MHz) (OEM qty).

A series of surface acoustic wave (SAW) bandpass filters eliminate the complex tuning procedures of L-C and discrete crystal filters. The SAW filters offer a flat group delay, controlled amplitude and time response and phase linearity. The parts measure 2.35 × 1.15 × 0.4 in. and find use in rf receivers, frequency synthesizers and equalizers for digital data system. Center frequencies of 70 and 150 MHz are offered.

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CIRCLE NUMBER 78

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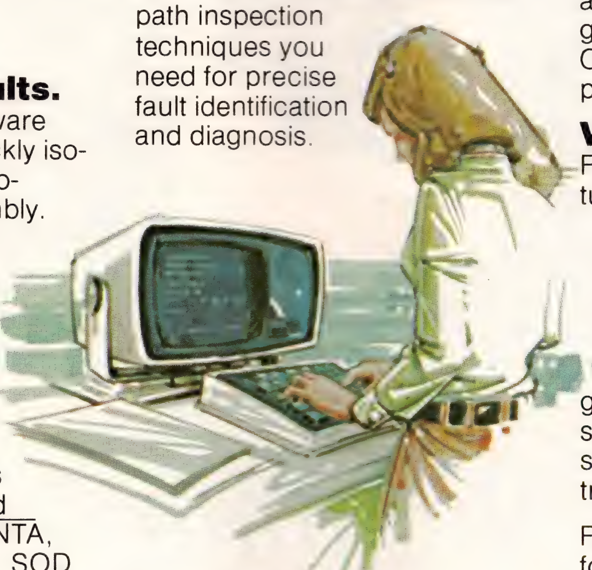
Fairchild's LSI know-how adds a new dimension to in-circuit testing.

LSI test know-how.
Fairchild knows about testing LSI. Virtually every LSI device devised by man has been tested on Fairchild's Xincom, Sentry® or Sentinel™ systems. That know-how has been applied to in-circuit testing with the development of the FF303's LSI Testing Module (LTM), to bring a new dimension to LSI testing.

LTM finds post-assembly faults.
LTM is part of a new software package designed to quickly isolate and identify faults introduced during PCB assembly. LSI test procedures first inspect an IC for orientation, adjacent shorts, opens and pins folded under. Strategic functional tests follow to verify the IC's operational integrity. An 8085 microprocessor, for example, is exercised for Address and Data Bus, HOLD, INTR, $\overline{\text{INTA}}$, 10/$\overline{\text{M}}$, TRAP, RESET, SIS, SOD, $\overline{\text{RD}}$, and $\overline{\text{WR}}$ functions* – all in about 20 milliseconds. No other in-circuit test system tests as fast and as thoroughly as the FF303.

Software support.
You need tests that are ready to run, or easily altered, so you can use your time for testing, not programming. The special tests you may need can be quickly and easily generated by using CHIPS, our unique LSI test language compiler. That's the kind of software support you get with the FF303 – along with our commitment to maintain the industry's largest LSI testing library for in-circuit testing.

The complete in-circuit tester.
Your PCBs do not live by LSI alone. So the FF303 is designed to test SSI, MSI, and the whole gamut of analog components. Faultfinder systems pioneered the analog in-circuit test method and the FF303 brings you the advanced component and circuit path inspection techniques you need for precise fault identification and diagnosis.



And you can choose from two different system analog and digital test point capacities with modular expansion as you need it.

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Your FF303 will do more than test. Its computer control lets you selectively run tests, file failure data, use the FAULTS automatic program generator and call, sort and file data quickly and easily. With real-time data logging, you can generate histograms to track PCB assembly failures by shift, day or week. And you can do more.

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Fairchild's Thinline® vacuum fixture system lets you choose from a wide variety of fixtures, fixture kits and universal personalizers. Build your own fixtures with Thinline kits or get turnkey testing with ready-to-test fixtures and programs. No other in-circuit test system manufacturer offers single-source fixturing and contract programming support.

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CIRCLE NUMBER 79

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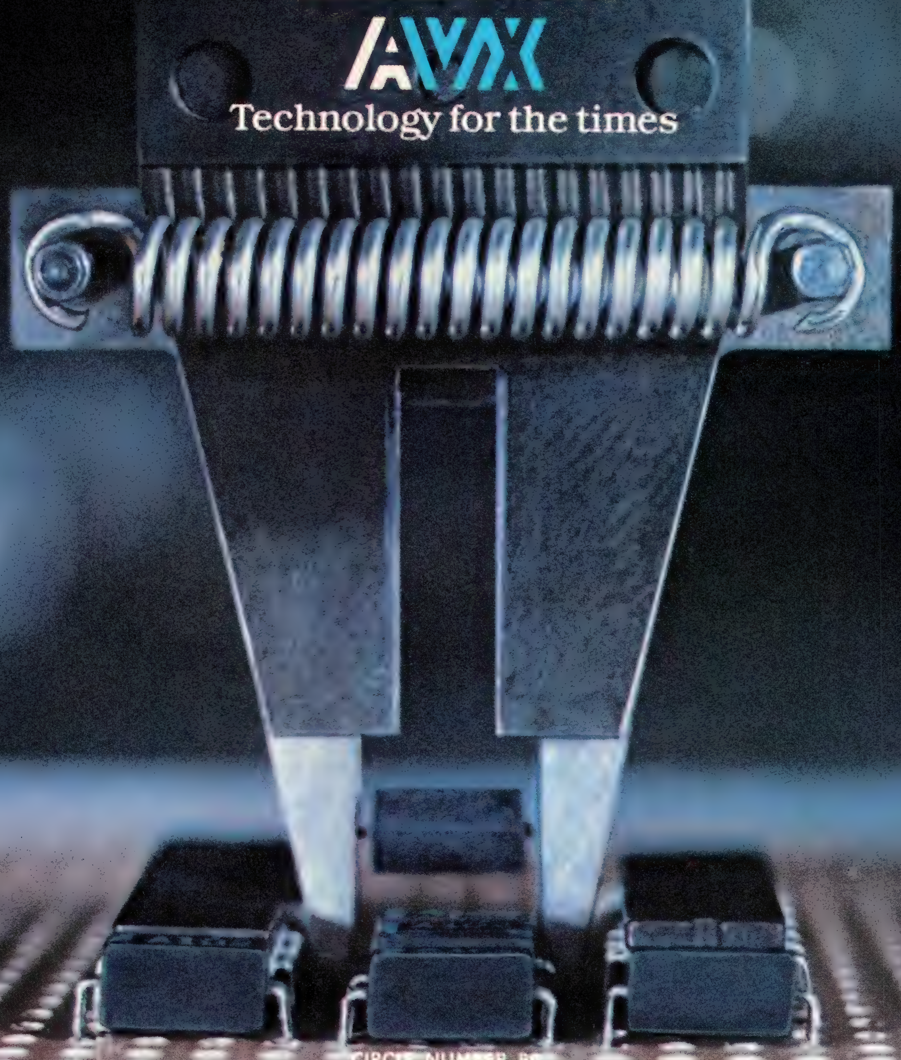
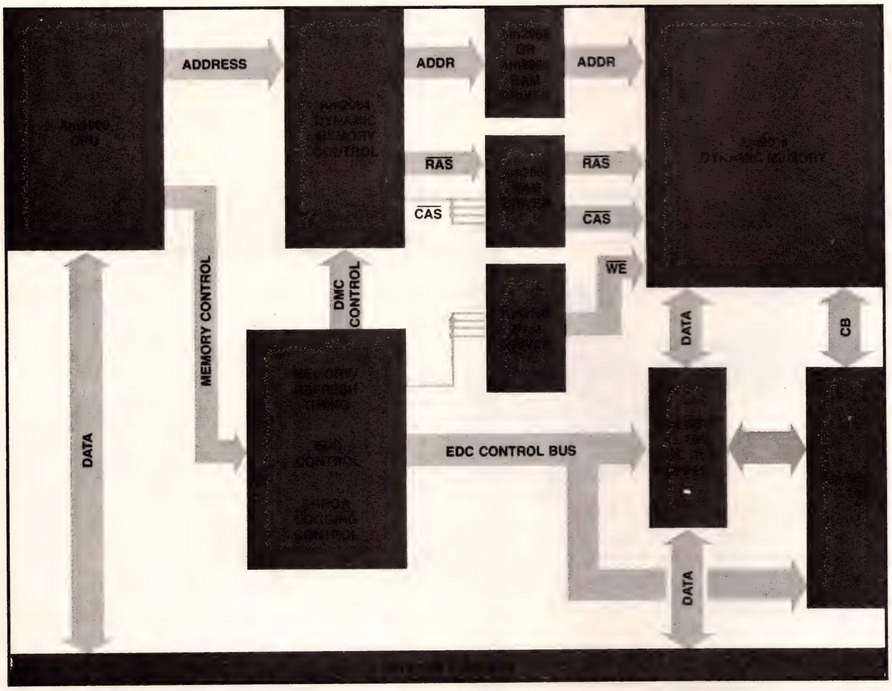


AVX
Technology for the times

Bipolar circuits divide—and conquer—support functions



Advanced Micro Devices, 901 Thompson Pl., Sunnyvale, CA 94086. (408) 732-2400. P&A: See text.

Each member of a new family of bipolar support circuits takes on a separate support function—giving exceptional performance in dynamic memory systems. The functional elements are a dynamic memory controller, special memory line drivers and buffers, an error detection and correction circuit and a refresh controller.

Two versions of each circuit will be available by the middle of this year: Circuits with the Am29 prefix will meet the specifications of bipolar bit-slice systems; those with the AmZ81 prefix will serve MOS processor systems.

The main circuits in the family are the Am2964 (AmZ8164) dynamic memory controller (DMC), the Am2960 (AmZ8160) error detection and correction circuit (EDC) and, for Z8000-based systems only, the AmZ8163 refresh timing and error control circuit. The first circuits, which have already been announced, are the Am2965/66 (or AmZ8165/66) octal address-line drivers for dynamic RAMs; following shortly will be the Am2961/62 (AmZ8161/62) multiport data-bus buffers.

In a typical MOS-processor system, the AmZ8164 DMC buffers and multiplexes the address lines of the CPU. Between the DMC and the address lines of the memory array are the AmZ8165 or 66 drivers. The data I/O pins of the memory array are buffered by the AmZ8161 or 62 circuits, with or without an AmZ8160 EDC, before the data are fed back to the memory and to the data bus. The Am29-type circuits function similarly in a bipolar system.

With a Z8000 CPU only, the AmZ8163 can also be in the loop, monitoring the EDC circuit and handling some of the timing control along with the DMC.

The 40-pin DMC chip includes an 8-bit refresh counter for handling both 16 and 64-k dynamic RAMs; two 8-bit latches; and a special $\overline{\text{RAS}}$ decoder and a $\overline{\text{CAS}}$ buffer, which minimize the time skew that could arise between outputs if separate MSI chips were used.

Housed in 24-pin 300-mil skinny DIPs, the 61 or 62-type data-bus buffers provide an interface that is just 4 bits wide. Each data-bus buffer has four 4-bit ports. The 61 buffer provides an inverting data path, and the 62 buffer provides a non-inverting data path, from the data bus to the EDC circuit. However, both provide inverting paths in the opposite direction. The buffers accept data from the memory, transfer the data to and from the EDC circuit and then transfer the data back to the memory or out to the system data-bus or both. Samples of the data-bus buffers should be available in the second quarter of this year.

The octal drivers are pin-compatible with 20-pin buffers, like the 74S240/244, but they are faster than the Schottky units and handle a −0.5 V undershoot. The 65-type driver is for inverted input data and the 66-type driver is for noninverted data.

The EDC circuit will be sampled near the beginning of the third quarter. The cascadable 16-bit error detection and correction circuit combines an ECL internal circuit with TTL-compatible periphery to perform at top speed. It detects multiple errors, corrects single-bit errors in a parallel data word and provides syndrome bits when an error occurs, so that the system can log the location of memory faults.

Towards the end of 1980, the AmZ8163 will appear. This dedicated circuit for Z8000-based systems fits between the CPU, the memory and the EDC circuit. It provides all the necessary timing from the basic CPU signals and system control via the syndrome bits of the EDC, when errors are detected.

Prices have not yet been established for most of the circuits. In 100-unit quantities, the 65 and 66-type drivers will cost $4.80; the 64-type DMC, $16.25 in plastic; and the 60-type EDC, approximately $60.

CIRCLE NO. 306

Dave Bursky
Semiconductors Editor

Octal memory drivers work with MOS RAMs

Advanced Micro Devices, 901 Thompson Pl., Sunnyvale, CA 94086. (408) 732-2400. From $4.80 (100 qty); stock.

Am2965 and Am2966, octal dynamic memory drivers with three-state outputs, drive the capacitive inputs of the address and control lines of MOS dynamic RAMs. Inclusion of an internal collector resistor in the lower output driver controls the output fall and undershoot without slowing the output rise. It also eliminates the need for an external resistor to protect RAMs from undershoot caused by standard Schottky drivers. Output undershoot is limited to −0.5 V maximum. Am2965 and Am2966 are pin-compatible with inverting 74S240 and non-inverting 74S244 devices. Typical power consumption is 450 mW from a 5-V dc source.

CIRCLE NO. 341

Low-cost 8-k RAM subs for 16-k types

National Semiconductor, 2900 Semiconductor Dr., Santa Clara, CA 95051. (408) 737-5000. $6.40 (100 qty); stock.

An 8-kbit dynamic RAM, MM5298, provides complete dc and ac compatibility with the 16-kbit MM5290. The low-cost device has a multiplexed address input with separate row and column strobes, allowing operation of the device in a page mode. Access times are 150, 200 and 250 ns. The TTL-compatible device offers 64 refresh cycles every 2 ms.

CIRCLE NO. 342

FIFO with parity ends need for separate chip

Monolithic Memories, 1165 E. Arques Ave., Sunnyvale, CA 94086. (408) 739-3535. $32 (67402); $48 (67402A); stock.

To make parity-checking easier, an additional data stream has been added to the basic 67401 first-in, first-out (FIFO) serial memory chip to create the 67402. The larger memory is five bits wide—four bits for data and one bit for checking parity. The device is organized into 64 five-bit words and operates at a 10-MHz data rate. An "A" version operates at 15 MHz.

CIRCLE NO. 343

Gate arrays operate at speeds to 20 MHz

Interdesign, 1255 Reamwood Ave., Sunnyvale, CA 94086. (408) 734-8666. P&A: See text.

Two high-speed gate arrays, MSA and MSB, operate at toggle rates to 20 MHz with typical propagation delays of 8 ns and a speed-power product of better than 1 pJ. The chips are current-mode logic arrays produced with a collector diffused isolation process. Each array cell contains two pairs of common-collector npn transistors, a current source with two active emitters, load resistors and crossunders. This architecture permits construction of two 2-input NOR gates within a single array cell. A 3-input NOR gate and a 2-input NAND gate also require just a single cell while a D flip-flop can be integrated using only three array cells. The chips are compatible with TTL, LSTTL and CMOS logic forms and have sufficient output power to drive LED displays.

CIRCLE NO. 344

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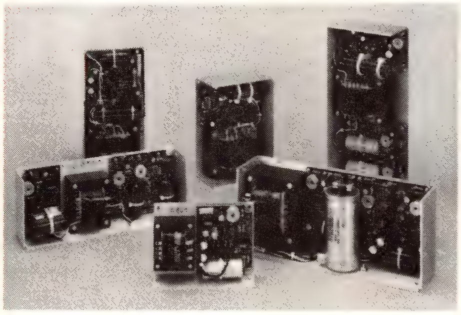

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+ 5V @ .5A/.7A PK	+ 12V @ .9A/1.8A PK	CP340	$ 44.95
+ 5V @ 2A	+ 12V @ 4A	CP323	$ 74.95

CP323 powers up to (4) drives simultaneously.

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+ 5V @ 2.5A	– 5V @ .5A	+ 24V @ 3A/3.4A PK	CP206	$ 91.95
+ 5V @ 3A	– 5V @ .6A	+ 24V @ 5A/6A PK	CP162	$120.00
+ 5V @ 1.7A/2.2A PK	– 5V @ .15A/.2A PK	+ 24V @ .2A/3A PK	CP272A	$ 91.95
+ 5V @ 2A	+ 12V @ .4A	– 12V @ .4A	HTAA-16W	$ 49.95

CP272A powers Persci Drives (includes unregulated 7 - 10V @ 1.2A/10A PK).
HTAA-16W powers Persci controller.

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CIRCLE NUMBER 112

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1657 RLC Digibridge

Our 1657 Digibridge gives you everything you need for basic RLC testing at a modest $1500. It's accurate to 0.2%, and lets you test at 1 kHz as well as 120 or 100 Hz. The 1657 gives you continuous measurements at 3 per second and the choice of series or parallel measurement modes.

1687 1 MHz LC Digibridge

In a 1 MHz tester our 1687 gives you 0.1% accuracy on C measurements, 0.2% accuracy on L measurements. You get most of the features of our 1658: automatic range selection, selectable measurement speeds, automatic limit comparison capability, external DC bias capability, and more. Like self-check diagnostics. At a cost of just $4000. Optionally, you can also get an IEEE bus/handler interface, external fixturing and a 1.0V rms test voltage.

1658 RLC Digibridge

For more critical measurements, our 1658 gives you the measurement accuracy of 0.1% at 1 kHz and 120 or 100 Hz. Its features include automatic limit comparison capability and selectable test speeds for fast error free measurements. Range selection is automatic and the 1658 has external DC bias capability, too. All for just $3,200. As an option an IEEE bus/handler package for data communication and high speed automated testing is available.

1688 Precision LC Digibridge

Our top of the line 1688 provides basic accuracy of 0.02%, a choice of 254 frequencies from 240 Hz to 20 kHz, and a 1 PPM D measurement resolution. Test speeds can be set at .5, 1.5, 3.0 or 7.0 measurements per second and test voltages at .25V or 1.0V. Of course range selection, limit comparison capability and self-check diagnostics are also included. And that's the most performance you can buy for $4900.

CIRCLE NUMBER 81

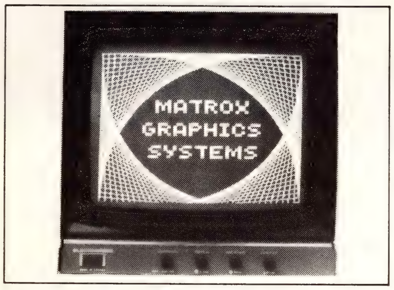
GenRad

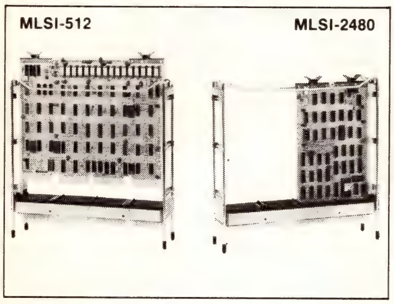
Put our leadership to the test.

(Prices shown are U.S.A. list.)

matrox

PDP-II and LSI-II bus displays





MATROX has the most complete line of CRT display boards for DEC's PDP-II and LSI-II bus in the industry. We have alphanumerics; graphics; color; black and white; variable resolution; external/internal sync; 50/60 Hz; software and much, much more. Just plug the board in any PDP/LSI-II bus connect video to any standard TV monitor, and presto, you have added a complete display to your system at a surprisingly low cost.

LSI-II BUS

MLSI-2480	24 x 80 alphanumerics
MLSI-256	256 x 256 dot graphics
MLSI-512 x 256	512 x 256 graphics
MLSI-512	512 x 512 graphics
MLSI-1024	1024 x 256 graphics

PDP-II BUS

MDC-2480	24 x 80 alphanumerics
MDC-256	256 x 256 dot graphics
MDC-512 x 256	512 x 256 graphics
MDC-512	512 x 512 graphics
MDC-1024	1024 x 256 graphics

And we have other uP displays and display controllers. These include state of the art OEM alphanumeric LED displays, alphanumeric video RAM's and CRT graphics controllers. They come as complete, ready to use sub-systems (single chips, modules, PCB's). Many of them are plug-in compatible with other buses Multibus SBC-80, S-100, Exorciser, STD as well as custom design capability.

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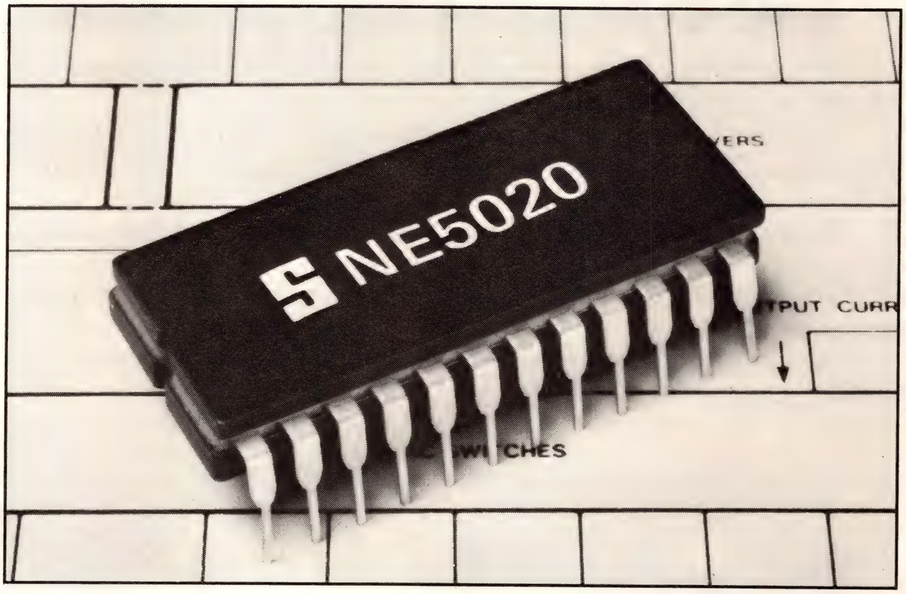
CIRCLE NUMBER 156

Complete 10-bit DAC has μP bus interface



Signetics, 811 E. Arques Ave., P.O. Box 409, Sunnyvale, CA 94086. (408) 739-7700. P&A: See text.

A complete 10-bit d/a converter interfaces with most microprocessor and logic-controlled systems. With 10-bit resolution, the NE5020 has relative accuracy of ±0.1%. Its monotonicity and accuracy are guaranteed over the converter's full operating temperature range of 0 to 70 C.

The 5020 is an extension of the company's NE5018 8-bit DAC. Its latches operate in one group of 8 bits and a second group of 2 bits. All latches have minimal loading and adjustable logic thresholds, as well as addressing capability.

The converter can settle to within 0.5 LSB in just 5 μs. Internal propagation delays (input to output) are 300 ns when the bit lines are switched low to high, and 150 ns when the lines switch high to low. The pulse width for the two latch-enable lines is 150 ns, minimum.

Along with the basic converter circuitry, which includes both current switches and ladder network, the 5020 has an on-chip band-gap voltage reference, and an output buffer amplifier, as well as matched application resistors for scaling either unipolar or bipolar output values. The output of the on-board buffer amplifier may be offset so as to provide unipolar operation over a range of 0 to 10 V or bipolar operation over a range of −5 to +5 V.

Housed in a 24-pin 600-mil DIP, the converter requires dual 15-V supplies, with a maximum current drain of 14 mA from the +15-V supply and 15 mA from the −15-V supply. Power dissipation totals 435 mW. When one supply varies from 13.5 to 16.5 V and the other supply is stable, output rejection for the varying supply stays at 0.01% full-scale per shift.

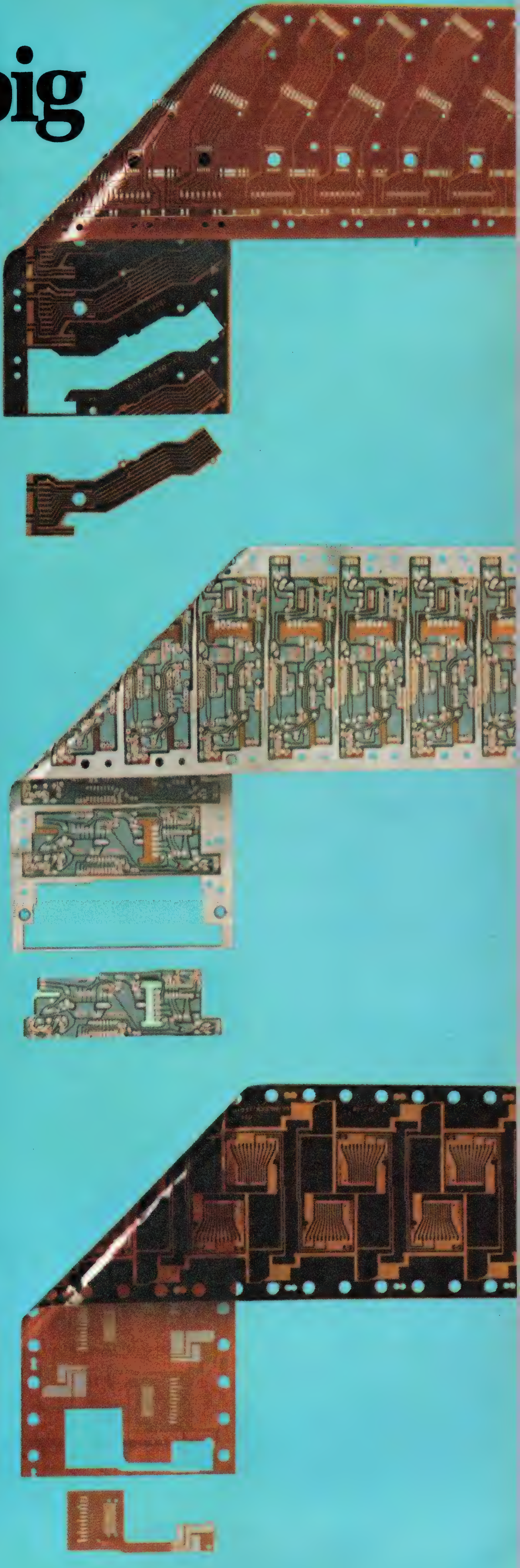
This self-contained 10-bit microprocessor-compatible DAC can interface with many of today's popular micro chips. Both its amplifier and its voltage reference are protected against short circuits.

Applications for the 5020 are numerous, including: precision 10-bit DACs, a building block for analog-to-digital converters, programmable power supplies, test equipment, measuring instruments, analog-digital multiplication, and the like.

In 100 quantity, the NE5020 costs $12 in a plastic DIP and $14 in a CERDIP. Delivery time ranges from stock to four weeks.

CIRCLE NO. 307

When you go big in flex circuits



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If your usage of flexible circuits will be high volume, start your new project with a company that can deliver.

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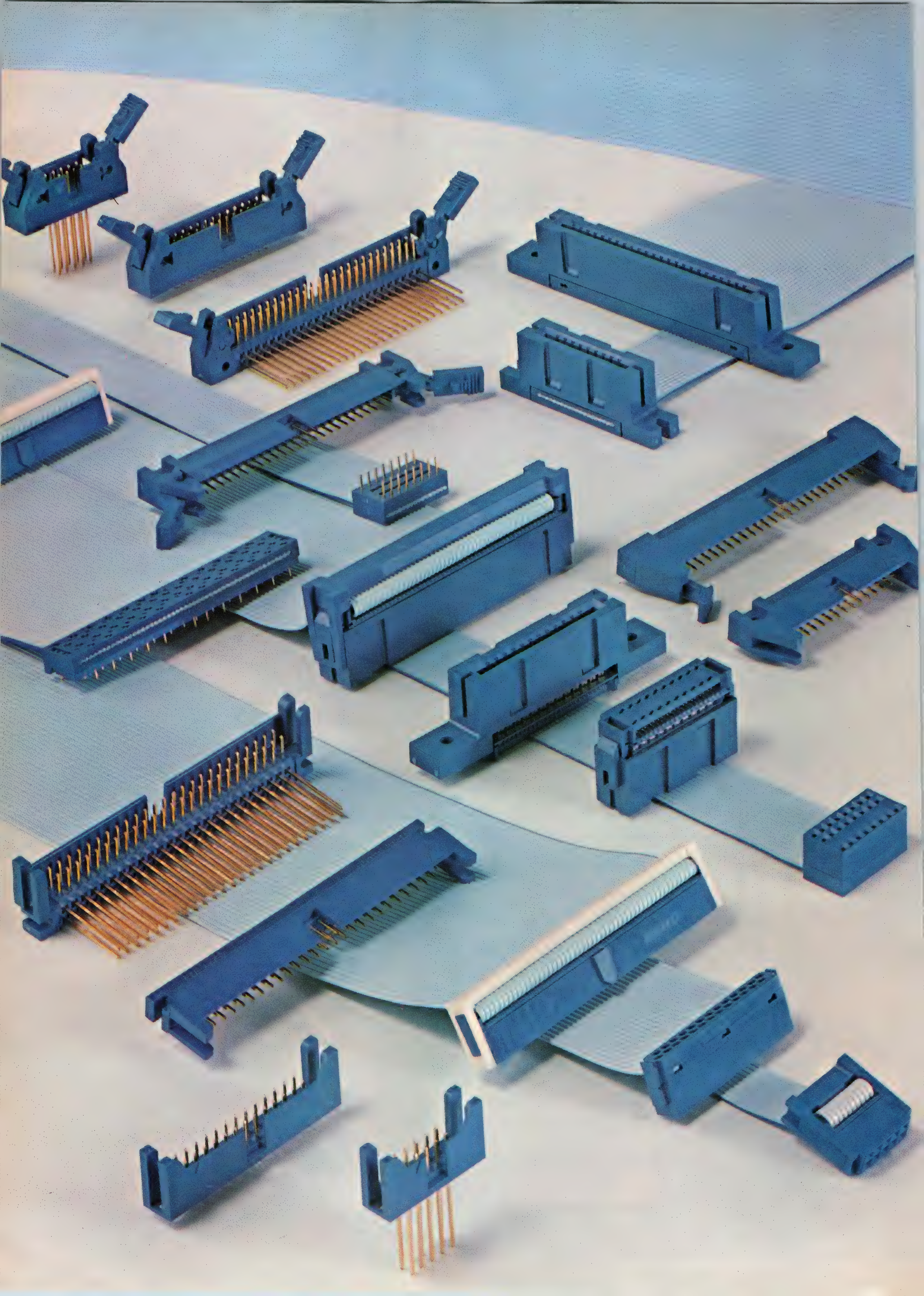
CIRCLE NUMBER 84   **CIRCLE NUMBER 166**



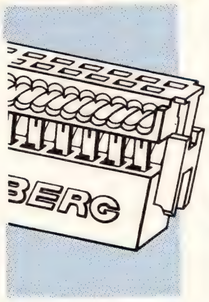
Quickie™: the total IDC System for design flexibility, fast assembly, reliable connections.

Meets a variety of interconnect needs.

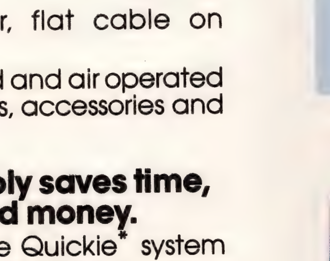
- A wide choice of connectors: "Quickie" and "Quickie" low-profile females, female IC, edge card, male DIP, PCB, and quick-eject vertical and right-angle headers ... all in a broad range of sizes.
- Round conductor, flat cable on 0.050'' centers.
- A selection of hand and air operated presses, cable shears, accessories and strain reliefs.

Efficient assembly saves time, material and money.

All connectors in the Quickie* system deliver reliable terminations in just a few seconds because:



- Cable slot designed to precisely position conductor for reliable termination, higher yields.
- Sight holes in cover permit visual inspection before and after assembly assuring proper cable alignment.

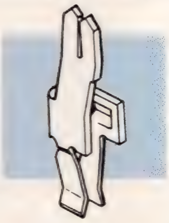


- The semi-automatic applicator completes terminations with a slide motion reducing assembly time. Or choose the manual applicator designed to minimize operator fatigue.

Over seven years proven performance. You can rely on "Quickie".

"Quickie" connectors are now specified by many of America's most quality conscious companies. Three high performance features demonstrate why:

1. Askewed tines firmly hold the wire for reliable termination.



2. Dual-beam contact assures redundant positive pin connection, even when subjected to vibration.

3. High-strength plastics withstand severe environments.

For a brochure giving details and complete specifications, write or call:

The Du Pont Company, Berg Electronics Division
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Telephone: (717) 938-6711.

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CIRCLE NUMBER 86

Gould Inc., Portable Battery Division, 931 N. Vandalia Street, St. Paul, Minnesota 55114, Telephone (612) 645-8531

Fast ADC module gets faster with 'progressive' design

Teledyne Philbrick, Allied Dr. at Rte. 128, Dedham, MA 02026. Ted Serafin (617) 329-1600. P&A: See text.

Upgrading the traditional successive-approximation circuit helps reduce typical conversion time in Teledyne Philbrick's 4134 a/d converter module from about 2.5 to 1.8 µs. The enhanced successive-approximation technique is called progressive approximation, which brings more speed to an already high-speed device by adding a clock control circuit to a conventional successive-approximation circuit (Electronic Design, March 29, 1980, p. 30).

The latest in a series of converters in the company's ultra-high-speed 4130 series, the 4134 is designed for high-speed data-acquisition systems and fast Fourier transform applications. Conversion time is guaranteed not to exceed 2.0 µs (0.5-MHz conversion rate), and the conversion-time temperature coefficient is guaranteed at ±2.8 ns/°C.

Nonlinearity is specified at ±1 LSB, and quantizing error is ±1/2 LSB. Temperature stability specifications include a nonlinearity of ±5 ppm/°C, and a gain error of ±20 ppm/°C. Another guarantee: The module will have no missing codes over a temperature range of 1 to 49 C.

The 4134 can do either single or repetitive conversions, both of which are user-programmable. In the single-conversion mode, an external pulse applied to the Start Convert input initiates operation at a conversion rate under user control. Repetitive conversions require that a single TTL inverter be externally connected to the Start Convert pin.

Digital outputs can be serial or parallel as well as unipolar or bipolar. Unipolar logic coding is binary, while bipolar outputs can be either offset binary or two's complement. The module is capable of driving ten TTL loads.

Two versions are available—one for 0 to 70 C, the other for −25 to +85 C and both monotonic over their full temperature range.

The 4134 is contained in a metal modular package measuring 4 × 2 × 0.42 in. The power-ground pin is tied to the metal case.

Three supplies are required to operate the module: +5 and ±15 V. Current drains are 325 mA from the 5 V, 65 mA from the +15 V and 45 mA from the −15 V. A special power supply made by the company, the 2243, provides the necessary levels.

Pricing for the 0 to 70 C version is $260 in quantities of 100 to 249 pieces. Availability is from stock to four weeks.

CIRCLE NO. 308

Quickie™, the total IDC System, is available through these leading Berg Electronics distributors:

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LoDan
415-592-4600
Glendale
Weatherford
213-849-3451
Inglewood
Force Electronics
213-776-1324
Palo Alto
Weatherford
415-493-5373
San Diego
Weatherford
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COLORADO
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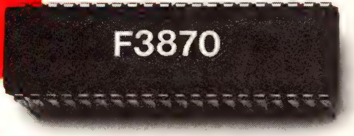
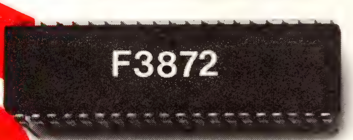
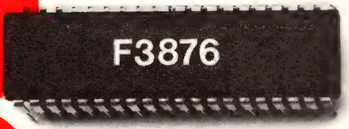
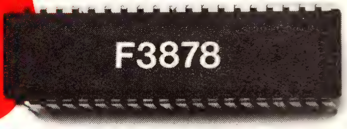
CIRCLE NUMBER 87

F3870 SERIES

Now that our microcomputers have more memory options, so do you.

DEVICE	RAM	ROM	I/O
 F3870	64 x 8	2K x 8	32
 F3872	128 x 8	4K x 8	32
 F3876	128 x 8	2K x 8	32
 F3878	64 x 8	4K x 8	32

We've just expanded our industry-standard F3870 line by adding three new microcomputers with increased on-chip memory options. Each is a complete 8-bit microcomputer on a single MOS chip and is 3870 pin-compatible.

Bigger ROM memories.

The series begins with the multi-source 3870 that gives you up to 2K bytes of ROM. With our three increased-memory versions, you can now get more features, a more sophisticated controller and more design flexibility.

Starting with the F3876 which offers 2K ROM, and the F3872 and F3878 which offer 4K ROM. These give the designer the size versatility he needs for almost every application, as well as allowing him to make smarter controllers.

POWER DOWN	POWER SUPPLY
NO	5V
YES	5V
YES	5V
NO	5V

More RAM with power-down protection.

The F3872 and F3876 offer 128 bytes of RAM, with 64 bytes available for power-down protection. That means that if your system shuts down, there's no memory loss, because the RAM remains powered and protected, with low current demand.

A microcomputer for all reasons.

No matter what your application needs, the F3870 series can meet them. It's an excellent choice for a wide variety of control applications, including terminals, communications, automotive and instruments. It's the perfect family of low-cost microcomputer circuits for the high-volume, cost-sensitive controller market.

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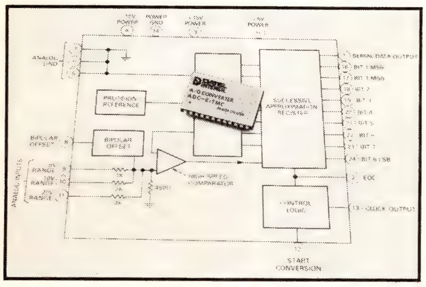
CIRCLE NUMBER 190

8-bit ADC converts in 600 ns, provides six input-voltage ranges



Datel-Intersil, 11 Cabot Blvd., Mansfield, MA 02048. Sumner Eagerman (617) 339-9341. $205; 8 to 12 weeks.

A hybrid 8-bit analog-to-digital converter completes a conversion in less than 600 ns. At this speed, the ADC-815 is extremely useful for applications in radar, speech pattern recognition, computer typesetting, high-speed instruments and other data-acquisition and control systems, with sampling rates up to 1.67 MHz.

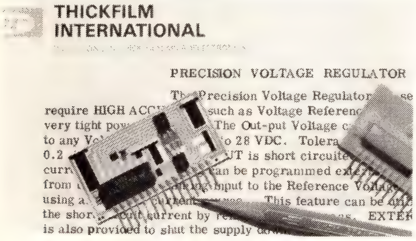
In a 24-pin ceramic DIP package, the device provides bipolar or unipolar pin-programmable, input voltages in six ranges; 0 to +5 V, 0 to +10 V, 0 to +20 V, ±2.5 V, ±5 V or ±10 V. Outputs include binary serial data, a clock output and a status output.

Conversion is performed by successive approximation, with the help of fast current-output DACs, strobed comparators, 8-bit successive approximation registers, precision reference and clock—all connected with thin-film resistors and interconnects. The gain tempco is within 20 ppm/°C for the operating range of 0 to +70 C, though units can be specified to operate from −65 to +125 C.

A three-part power supply is required: +15 V dc at 35 mA, −15 V dc at 15 mA and +5 V dc at 100 mA. Sensitivity to fluctuations in the power supply, however, is less than 0.02% for each change of 1%.

CIRCLE NO. 309

Voltage regulator spans 5 to 28 V



Thickfilm International, Rt. 1, Box 85-0, Indian Head, MD 20640. (301) 375-8666. Under $4.50 (1000 qty); stock to 8 wks.

A precision voltage regulator offers control over its output from 5 to 28 V dc. Tolerance is 0.2, 0.5 or 1%. Programmable current-limiting provides short-circuit protection. The hybrid device comes on a 1 × 2-in. ceramic substrate and operates from 0 to 70 C. Input voltage range is 9.5 to 40 V dc; output current, 150 mA maximum. An external inhibit function is available to shut down the supply.

CIRCLE NO. 345

Single CMOS chip drives vacuum display

Intersil, 10710 N. Tantau Ave., Cupertino, CA 95014. Dale Prull (408) 996-5100. $3.75 (100 qty); stock.

A monolithic CMOS device, ICM7235, drives non-multiplexed, 4-digit vacuum-fluorescent displays. The device provides 28 high-voltage, open-drain, P-channel transistor outputs, organized as four 7-segment digits. Up to six TTL or CMOS ICs can be eliminated from display-driver circuits by using the ICM7235. Versions of the chip are available with multiplexed BCD input or with a high-speed processor interface. Outputs can be Hex or Code B. The non-multiplexed driver avoids generation of RFI. Inputs feature display blanking and full protection against static discharge. A brightness control allows display dimming in low ambient light levels. The ICM7235 comes in a plastic 40-pin DIP and operates over a −20 to +70 C range.

CIRCLE NO. 346

TI Distributors

Distributor List

ALABAMA: Huntsville, Hall-Mark (205) 837-8700.

ARIZONA: Phoenix, Kierulff Electronics (602) 243-4101; R.V. Weatherford (602) 272-7144; **Tempe**, Marshall Industries (602) 968-6181.

CALIFORNIA: Anaheim, R.V. Weatherford (714) 634-9600; **Canoga Park**, Marshall Industries (213) 999-5001; **Chatsworth**, JACO (213) 998-2200; **Costa Mesa**, TI Supply (714) 979-5391; **El Monte**, Marshall Industries (213) 686-0141; **El Segundo**, TI Supply (213) 973-2571; **Glendale**, R.V. Weatherford (213) 849-3451; **Goleta**, RPS (805) 964-6823; **Irvine**, Marshall Industries (714) 556-6400; **Los Angeles**, Kierulff Electronics (213) 725-0325; RPS (213) 748-1271; **Mountain View**, Time Electronics (415) 965-8000; **Palo Alto**, Kierulff Electronics (415) 968-6292; **Pomona**, R.V. Weatherford (714) 623-1261; **San Diego**, Arrow Electronics (714) 565-4800; Kierulff Electronics (714) 278-2112; Marshall Industries (714) 278-6350; R.V. Weatherford (714) 278-7400; **Santa Barbara**, R.V. Weatherford (805) 465-8551; **Sunnyvale**, Arrow Electronics (408) 739-3011; Marshall Industries (408) 732-1100; TI Supply (408) 732-5555; United Components (408) 737-7474; **Torrance**, Time Electronics (213) 320-0880; **Tustin**, Kierulff Electronics (714) 731-5711.

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GEORGIA: Doraville, Arrow Electronics (404) 449-8252; **Norcross**, Wilshire Electronics (404) 923-5750.

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INDIANA: Ft. Wayne, Ft. Wayne Electronics (219) 423-3422; **Indianapolis**, Graham Electronics (317) 634-8202.

IOWA: Cedar Rapids, Deeco (319) 365-7551.

KANSAS: Lenexa, Component Specialties (913) 492-3555; **Shawnee Mission**, Hall-Mark/Kansas City (913) 888-4747; **Wichita**, LCOMP Inc. (316) 265-8501.

MARYLAND: Baltimore, Arrow Electronics (202) 737-1700, (301) 247-5200; Hall-Mark/Baltimore (301) 796-9300; **Columbia**, Diplomat/Maryland (301) 995-1226; **Rockville**, Milgray/Washington (301) 468-6400.

MASSACHUSETTS: Billerica, Kierulff Electronics (617) 667-8331; **Burlington**, Wilshire Electronics (617) 272-8200; **Waltham**, TI Supply (617) 890-0510; **Woburn**, Arrow Electronics (617) 935-8080; Time Electronics (617) 935-8080.

MICHIGAN: Ann Arbor, Arrow Electronics (313) 971-8220; **Oak Park**, Newark Electronics (313) 967-0600; **Grand Rapids**, Newark Electronics (616) 241-6681.

MINNESOTA: Edina, Arrow Electronics (612) 830-1800; **Plymouth**, Marshall Industrials (612) 559-2211.

MISSOURI: Earth City, Hall-Mark/St. Louis (314) 291-5350; **Kansas City**, Component Specialties (913) 492-3555; LCOMP Inc.-Kansas City (816) 221-2400; **St. Louis**, LCOMP Inc.-St. Louis (314) 291-6200.

NEW HAMPSHIRE: Manchester, Arrow Electronics (603) 668-6968.

NEW JERSEY: Camden, General Radio Supply (609) 964-8560; **Cherry Hill**, Milgray/Delaware Valley (609) 424-1300; **Clark**, TI Supply (201) 382-6400; **Clifton**, Wilshire Electronics (201) 340-1900; **Fairfield**, Kierulff Electronics (201) 575-6750; **Moorestown**, Arrow Electronics (609) 235-1900; **Saddlebrook**, Arrow Electronics (201) 797-5800.

NEW MEXICO: Albuquerque, Arrow Electronics (505) 243-4566; International Electronics (505) 262-2011; United Components (505) 345-9981.

NEW YORK: Endwell, Wilshire Electronics (607) 754-1570; **Farmingdale**, Arrow Electronics (516) 694-6800; **Freeport**, Milgray Electronics (516) 546-6000, N.J. (800) 645-3986; **Hauppauge**, Arrow Electronics (516) 231-1000; JACO (516) 273-5500; **Liverpool**, Arrow/Syracuse (315) 652-1000; **Melville**, Diplomat (516) 454-6334; **New York**, Wilshire Electronics (212) 682-8707; **Rochester**, Arrow/Rochester (716) 275-0300; Rochester Radio Supply (716) 454-7800; Wilshire Electronics (716) 235-7620.

NORTH CAROLINA: Raleigh, Hall-Mark (919) 832-4465; **Winston-Salem**, Arrow Electronics (919) 725-8711.

OHIO: Cleveland, TI Supply (216) 464-6100; **Columbus**, Hall-Mark/Ohio (614) 846-1882; **Dayton**, ESCO Electronics (513) 226-1133; Marshall Industries (513) 236-8088; **Kettering**, Arrow Electronics (513) 253-9176; **Reading**, Arrow Electronics (513) 761-5432; **Solon**, Arrow Electronics (216) 248-3990.

OKLAHOMA: Tulsa, Component Specialties (918) 664-2820; Hall-Mark/Tulsa (918) 835-8458; TI Supply (918) 749-9543.

OREGON: Beaverton, Almac/Stroum Electronics (503) 641-9070; **Milwaukie**, United Components (503) 653-5940.

PENNSYLVANIA: Huntington Valley, Hall-Mark/Philadelphia (215) 355-7300; **Pittsburgh**, Arrow Electronics (412) 351-4000.

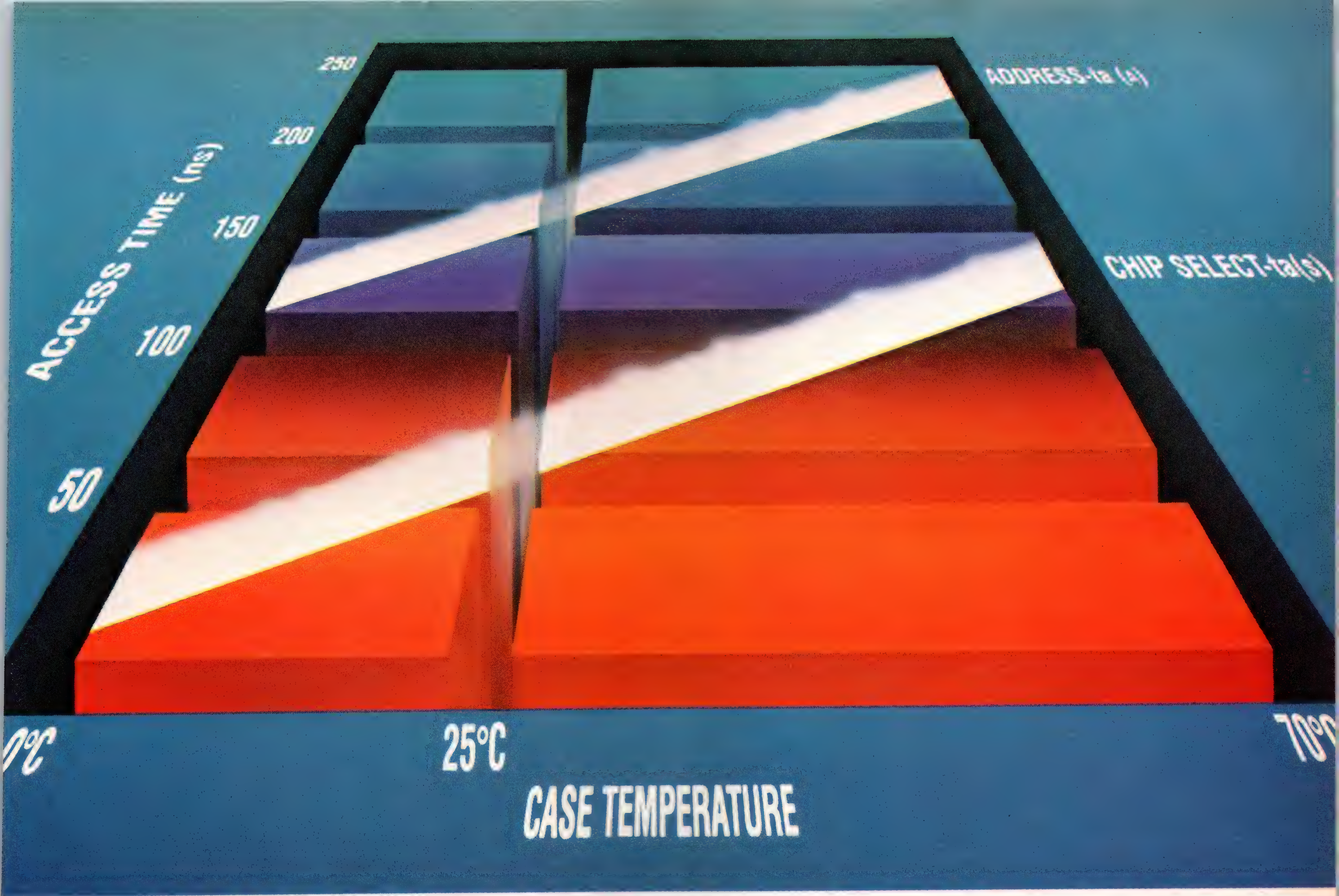
TEXAS: Austin, Component Specialties (512) 837-8922; Hall-Mark/Austin (512) 837-2814; **Dallas**, Component Specialties (214) 357-6511; Hall-Mark/Dallas (214) 234-7400; International Electronics, (214) 233-9323; TI Supply (214) 238-6821; **El Paso**, International Electronics (915) 778-9761; **Houston**, Component Specialties (713) 771-7237; Hall-Mark/Houston (713) 781-6100; Harrison Equipment (713) 652-4700; TI Supply (713) 776-6511.

UTAH: Salt Lake City, Diplomat/Altaland (801) 486-4134; Kierulff Electronics (801) 973-6913.

WASHINGTON: Redmond, United Components (206) 885 1985; **Seattle**, Almac/Stroum Electronics (206) 763-2300, Kierulff Electronics (206) 575-4420; **Tukwila**, Arrow Electronics (206) 575-0907.

WISCONSIN: Oak Creek, Arrow Electronics (414) 764-6600; Hall-Mark/Milwaukee (414) 761-3000; **Waukesha**, Kierulff Electronics (414) 784-8160.

CANADA: Calgary, Cam Gard Supply (403) 287-0520; **Downsview**, CESCO Electronics (416) 661-0220; **Edmonton**, Cam Gard Supply (403) 426-1805; **Halifax**, Cam Gard Supply (902) 454-8581; **Kamloops**, Cam Gard Supply (604) 372-3338; **Moncton**, Cam Gard Supply (506) 855-2200; **Montreal**, CESCO Electronics (514) 735-5511; Future Electronics (514) 731-7441; **Ottawa**, CESCO Electronics (613) 729-5118; Future Electronics (613) 820-8313; **Quebec City**, CESCO Electronics (418) 687-4231; **Regina**, Cam Gard Supply (306) 525-1317; **Saskatoon**, Cam Gard Supply (306) 652-6424; **Toronto**, Future Electronics (416) 663-5563; **Vancouver**, Cam Gard Supply (604) 291-1441; Future Electronics (604) 438-5545; **Winnipeg**, Cam Gard Supply (204) 786-8481. U



The fastest 8K EPROM ever. TMS2508. Available now. From Texas Instruments.

High speed. Reprogrammability. Family compatibility. And availability.

Just a few of the many practical reasons why you should consider the newest member of TI's 5-V Family. TMS2508. An 8K EPROM specifically designed for high-speed.

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At 250-ns max access time, 180-ns typical, the TMS2508 is the fastest EPROM on the market. So fast, in fact, that you can design it in for all state-of-the-art microprocessors and not worry about sacrificing performance. The TMS2508 reduces wait states and virtually eliminates the need for any additional wait-state circuitry.

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Because the TMS2508 is so fast, it also allows you to implement many memory applications previously served only by bipolar PROMs. Only minor board modifications are required to make the switch from bipolar to MOS. (For complete details see Applications Note MM-2508.) And, unlike PROMs, the TMS2508 can be easily and quickly erased and reprogrammed. At any time.

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For free samples, write to TI on your letterhead, briefly describing your proposed TMS2508 application. Write to Texas Instruments Incorporated, Dept. S2508, P.O. Box 1443, M/S 6965, Houston, Texas 77001.

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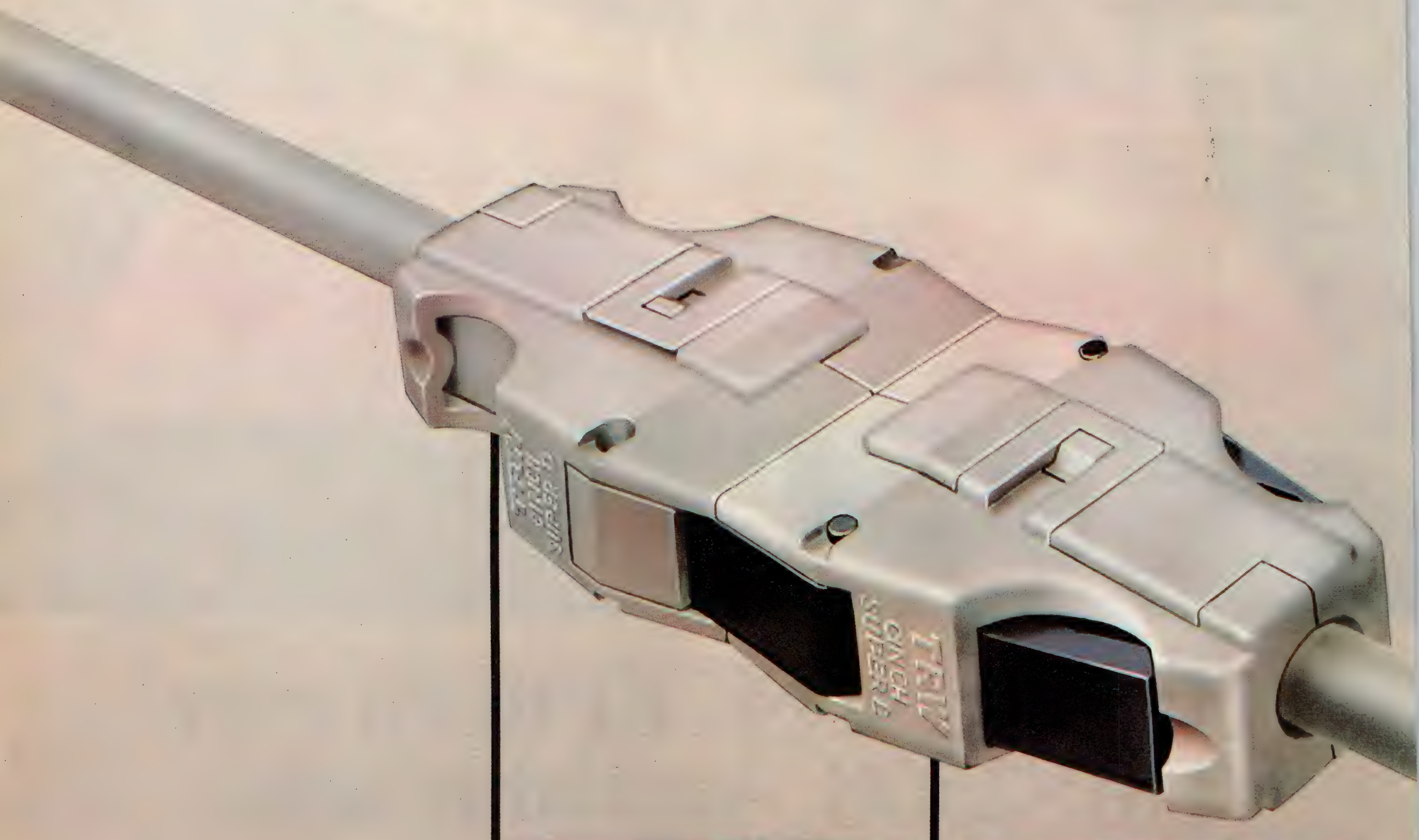
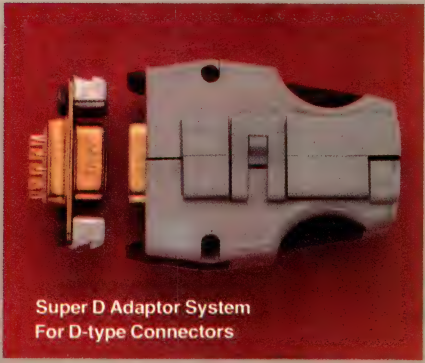
CIRCLE NUMBER 89

85131C

Super D*



Rapid Solderless Termination 4-point Contact Eliminate Wire Stripping.


Super D Adaptor System For D-type Connectors

Choose From Four Standard Super D Connector Sizes... 9 (on left), 15, 25, and 37 (right) contacts.

*Trademark TRW Inc.

U.S. Patent Nos.
3,902,154 4,035,049 4,090,770
other Patents Pending

A unique all plastic snap-locking connector system that costs less and does more than standard D-Subs.

Here's Why Super D* is "The D With The Difference".

Different? You bet! TRW Cinch's all new Super D connector system has the exclusive design features and cost-saving benefits that move it to the top of any D-Sub line!

Let's begin with cost savings. Most D-subs require soldering or crimping. Not Super D connectors. Our new pre-loaded pin/socket contacts provide solderless insulation displacement 4-point termination. This unique contact also gives you twice as many contact points at mating end as other D-sub designs. All without wire prepping or stripping. Result? Immediate assembly time reduction and a positive cost savings with increased reliability!

But that's not all! Besides fast, solderless termination, Super D connectors also have snap-on plastic hoods that feature an exclusive Latch-N-Lock design for positive, audible locking with no additional tools, parts or labor. Just push to connect, squeeze and pull to disconnect. It's that easy!

To convert standard TRW Cinch D-subs to the Super D system, ask us about our special adaptor system for D-type connectors.

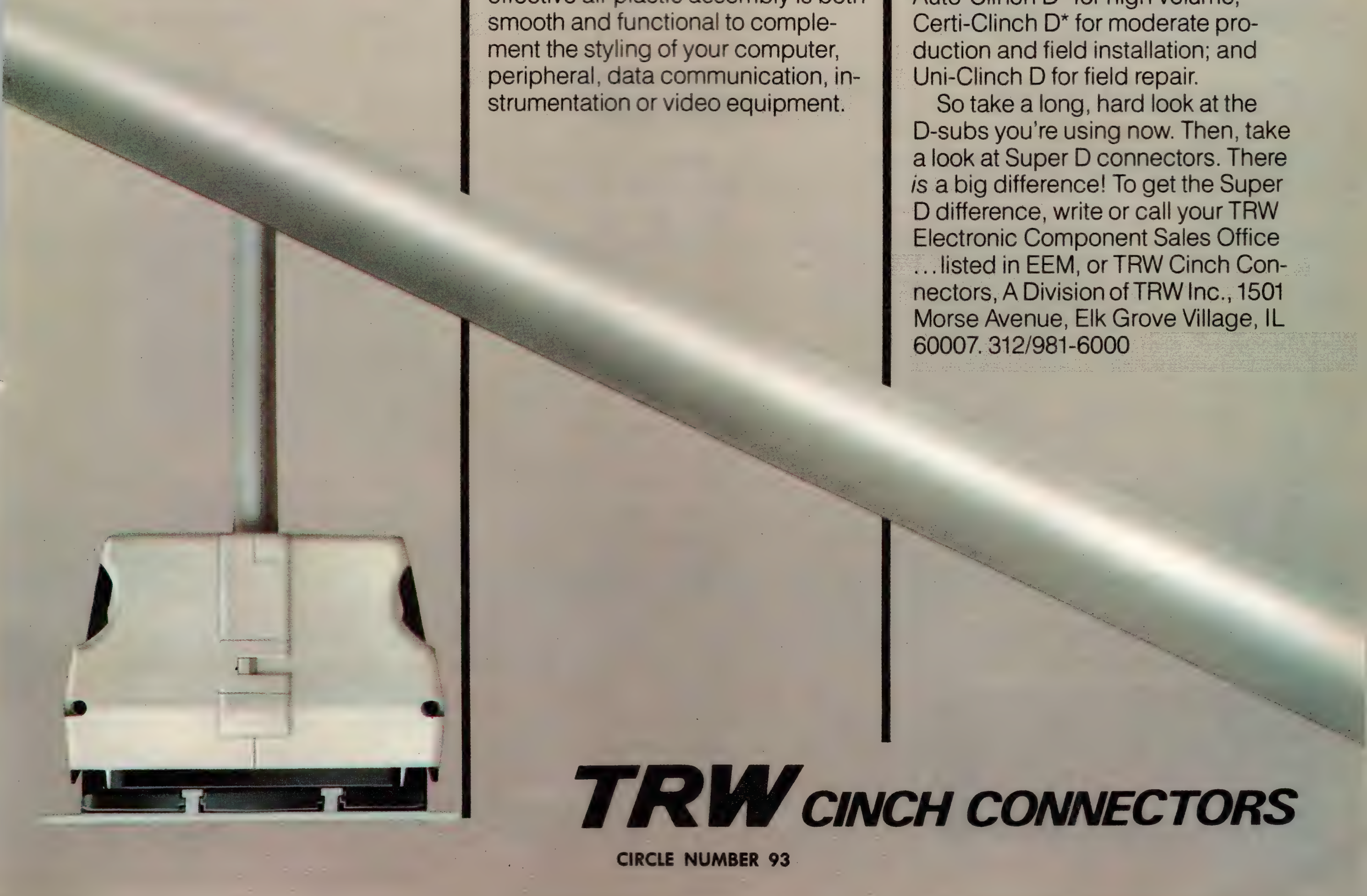
Looking for style and design? Look no further! Super D's cost-effective all-plastic assembly is both smooth and functional to complement the styling of your computer, peripheral, data communication, instrumentation or video equipment. This plastic design effectively insures against shock hazards.

Super D connectors employ *selective* gold plating only where it is needed. We've eliminated expensive gold from non-functioning surfaces. So you get performance without added cost.

The Super D connector is available in four sizes (9, 15, 25, and 37 contacts) for cable-to-cable and cable-to-panel modes. Each will intermate with existing D-type connectors. And, you'll be glad to know that the Super D system is designed to meet EIA Standard RS449 plus IS04902 and 4903 for your DTE and DCE equipment.

To further speed your termination time, TRW Cinch has designed three terminating tools specifically for the Super D connector system. Use Auto-Clinch D* for high volume; Certi-Clinch D* for moderate production and field installation; and Uni-Clinch D for field repair.

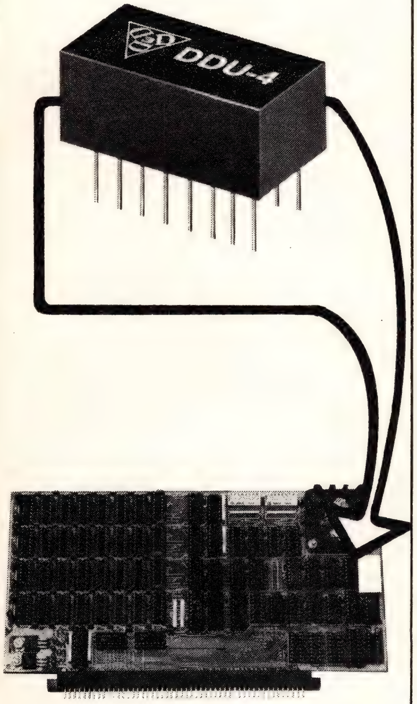
So take a long, hard look at the D-subs you're using now. Then, take a look at Super D connectors. There *is* a big difference! To get the Super D difference, write or call your TRW Electronic Component Sales Office ... listed in EEM, or TRW Cinch Connectors, A Division of TRW Inc., 1501 Morse Avenue, Elk Grove Village, IL 60007. 312/981-6000



TRW CINCH CONNECTORS

CIRCLE NUMBER 93

Unsure About Dynamic RAMS Timing In Your Memory Boards?



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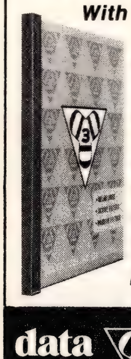

- Fast rise — Time on all taps
- Each tap isolated with TTL Fan-out capabilities
- Exact delay at each tap
- 2,000 NS total delay
- Up to 10 taps
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Request complete catalog

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CIRCLE NUMBER 155

Complete 12-bit DAC interfaces to μP data bus

Beckman Instruments, 2500 Harbor Blvd., Fullerton, CA 92634. (714) 773-7874. $24.50 (100 qty).

A complete 12-bit DAC, Model 7581C, uses programmable input registers for serial or parallel data transfer to 8, 12 or 16-bit microprocessor data buses. External connections allow selection of standard output voltage ranges of 0 to 5 V, 0 to 10 V, ±2.5 V, ±5 V or ±10 V. The unit contains input registers, an R-2R ladder network, switches and level shifters, a reference and an output buffer amplifier—all in a 36-pin package. The device operates with power supplies ranging from ±12 to ±17 V and can be directly driven by TTL or CMOS logic. Model 7581C provides access to voltage reference of 8.5 V, 6.5 V and −8 V for system use.

CIRCLE NO. 347

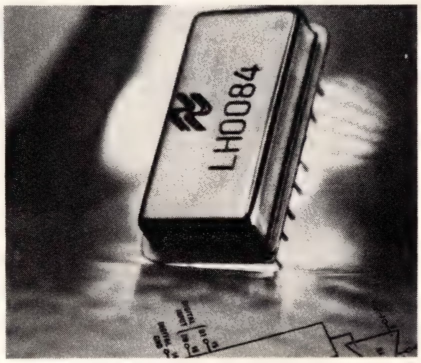
Regulator limits dropout to reduce power waste

National Semiconductor, 2900 Semiconductor Dr., Santa Clara, CA 95051. (408) 737-5000. P&A: See text.

A series of three-terminal positive voltage regulators, the LM330 and the LM2930, keep internal voltage drop to only 0.6 V to reduce power dissipation in the regulator. This means easy heat sinking and lower operating temperatures. Each device in the series features reverse battery protection, insurance against damage from negative voltage inputs. The LM2930 has internal 40-V load dump protection. This device, with an operating range of −40 to +85 C, is especially suited to automotive use. The LM330 is intended for commercial use and comes in a plastic TO-220 package with a fixed 5-V output. The device has an operating temperature range of 0270 C. LM2930 is offered with fixed outputs of 5 or 8 V and comes in a plastic TO-220 case. In quantities of 100, LM330 sells for $0.85; LM2930, $0.90.

CIRCLE NO. 348

Instrument amp input programs via resistors

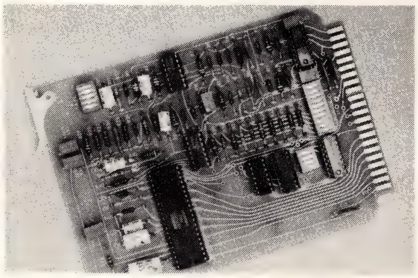


National Semiconductor, 2900 Semiconductor Dr., Santa Clara, CA 95051. (408) 737-5000. $39.50; 6 wks.

A hybrid instrumentation amplifier, LH0084, features programmable gain settings established by laser-trimmed thin-film resistors. The device is intended for high-speed, multiplexed data acquisition systems. Typical settling time to 0.01% is only 5 μs. Input impedance is 10^{11} Ω; typical gain drift, 1 ppm /°C. The 16-pin device contains two sections. The first contains a pair of programmable variable-gain amplifiers with FETs at each input. This is followed by a differential-to-single-ended output stage with pin-programmable gain. Film resistors establish gains of 1, 2, 5 or 10 at the input while pin-strapping yields gains of 1, 4 or 10 at the output.

CIRCLE NO. 349

A/d converter conditions strain gauge output to μC



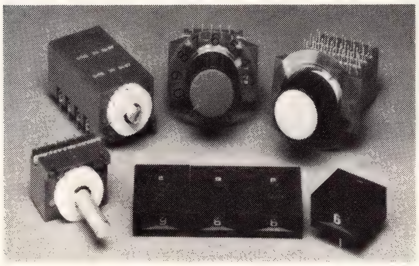
Acrotech, 1160 E. Ash Ave., Fullerton, CA 92631. (714) 879-8470. $425.

An a/d converter, P/N 50048, provides a direct interface between a strain gauge and a microcomputer—all on a single card. Ratiometric operation minimizes transducer excitation supply stability requirements. Convert and three-state output-to-bus commands are addressable. The converter needs only a single 5-V dc supply. Resolution is 0.025% for a 2 mV/V transducer signal.

CIRCLE NO. 354

Components

Tiny switches mount directly to PC boards

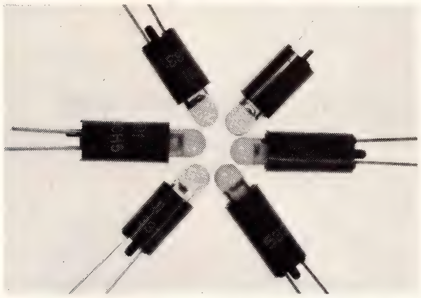


Interswitch, 770 Airport Blvd., Burlingame, CA 94010. (415) 347-8217.

Tiny rotary and thumbwheel switches mount directly to PC boards. GWS series thumbwheel switches come with 10 or 16 positions and with a choice of six different coded ouputs and two wheel colors. A choice of markings allows mounting of the switches in any orientation. GRS rotary switches are offered in a variety of codes and can be mounted parallel or perpendicular to a board. The parts are also mountable on front panels.

CIRCLE NO. 355

LED indicators light PC mounted switches



Industrial Devices, 7 Hudson Ave., Edgewater, NJ 07020. (201) 224-4700. $0.39 (1000 qty); stock.

Bright LED indicator-light assemblies, Series 5330 and 5331, illuminate PC-board mounted rocker, toggle and pushbutton switches. Series 5330 devices fit panel-hole openings and Series 5331 LEDs backlight panel overlays. Both types press into holes on a board or into a switch bezel. A mounting base includes a board standoff to prevent flux entrapment and permit easy cleaning. Molded-in base pins are used for exact positioning and fast hand insertion. Series 5330 indicators use wide-angle LEDs while 5331 types incorporate narrow-beam LEDs. All LEDs are available in red, green and yellow colors.

CIRCLE NO. 356

You may need it to drive an ultrasonic transducer. Or deliver cw or swept frequency signals at a usable field strength for rfi susceptibility testing. Or for NMR research involving both broadband and high-power capabilities.

In any event, you needn't look beyond Amplifier Research for the right answers. Bandwidths? Choose from sub-octave to five-decade models with top frequencies up to 1 GHz. Output power? How's one watt up to 10 kW?

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When you command your rf power from AR, the chances are very good that we'll have whatever combination you seek—clean bandwidth, reliable output power, linearity as needed, pulse capability, adjustable gain—often in an amplifier about half the size of its nearest "competitor."

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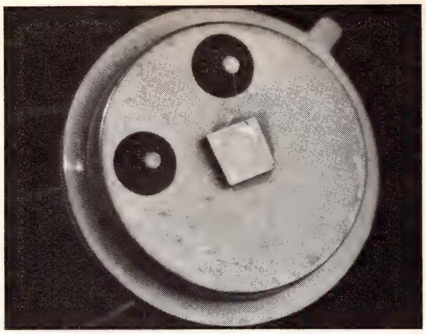
CIRCLE NUMBER 83

Sensor chip spots destructive moisture in IC packages

Panametrics, 221 Crescent St., Waltham, MA 02154. (617) 899-2719. P&A: $6 (5000 qty.); 4 wks.

Installed within the package of a microcircuit, the Mini-Mod-HT sensor determines the moisture levels and hermeticity of the device. The tiny (60 × 60-mil) sensor chip checks moisture levels throughout the manufacture, operation and shelf-life of an IC—giving advance warning of device failure at a low cost and chopping weeks off the time required for mass spectrometry testing.



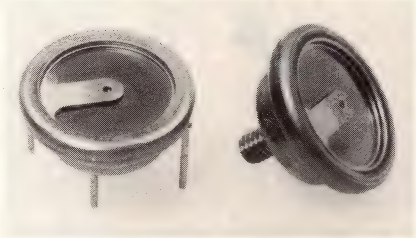
The sensor consists of an aluminum base and an anodized, porous, oxide layer covered by a thin film of gold. The base and the gold form the electrodes of, essentially, an Al_2O_3 capacitor.

Water-vapor molecules transport through the gold layer and equilibrate on the pore walls of the oxide. The number of water molecules absorbed on the oxide affects the impedance of the pore wall. An hygrometer, such as the Model 771, reads out the moisture level directly.

The sensor operates with good reproducibility, even after being subjected to sealing temperatures as high as 500 C. Only one bond wire is needed when the chip's substrate is continuous to a pin connection.

CIRCLE NO. 322

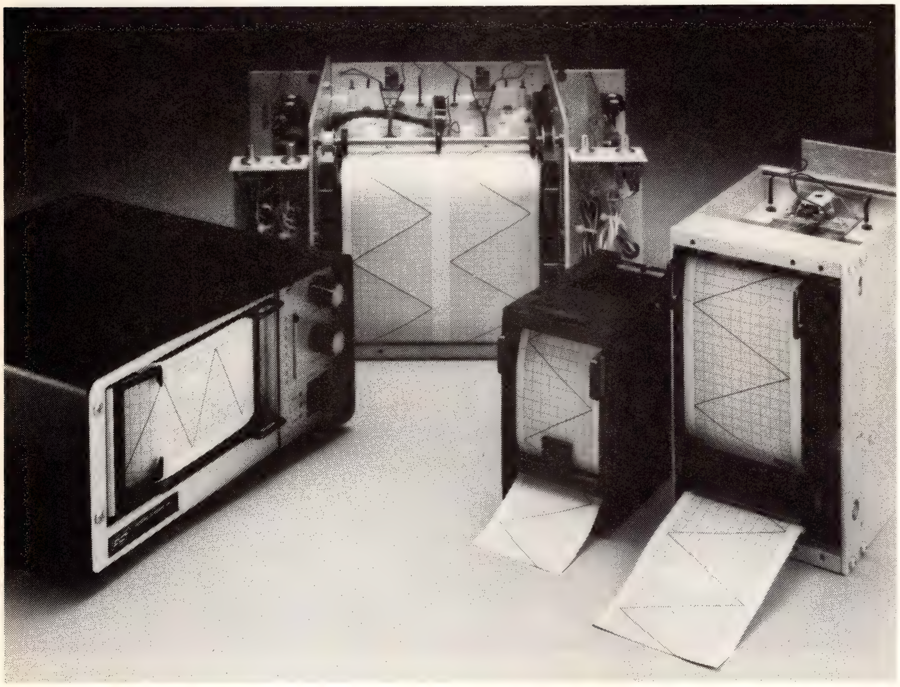
Wet tantalum caps give high capacity in small area



Plessey Capacitors, 5334 Sterling Center Dr., Westlake Village, CA 91361. (213) 889-4120.

W13 series wet tantalum capacitors offer large values of capacitance in minimum space requirements. The wet slug units, in either PC-mount or stud-mount versions, have no metal migration. Standard range is 47 to 1200 μF in models from 6 to 125 V dc. The capacitors are manufactured to meet the requirements of MIL-C-83500/1 and satisfy the need for an input and output filter in static inverters, pulse-modulated and switching regulators and other power supply applications.

CIRCLE NO. 357



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For complete information, circle the readers service number or write today, General Scanning Inc., 500 Arsenal Street, Watertown, MA 02172, Telephone (617) 924-1010.

GENERAL SCANNING INC.

CIRCLE NUMBER 116

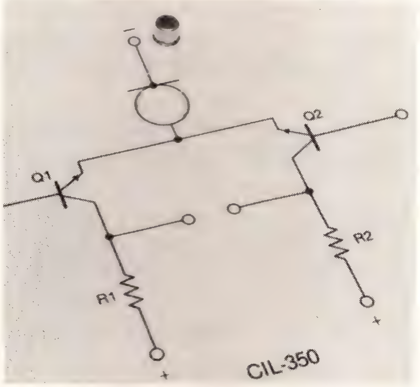
Low ESR cuts losses in ceramic chip capacitors

Centre Engineering, 2820 E. College Ave., State College, PA 16801. (814) 237-0321. 12 wks.

Reduction of heating losses, the result of low equivalent series resistance (ESR) in HF series ceramic chip capacitors, cuts signal losses. The parts satisfy high-frequency requirements above 100 MHz. ESR values are in the range of 0.05 Ω. With lower signal attenuation, less stages of amplification are required in rf amplifiers. Standard chip sizes include 0.08 × 0.05 in. and 0.125 × 0.095 in.

CIRCLE NO. 358

Regulating diodes tackle currents to 50 mA

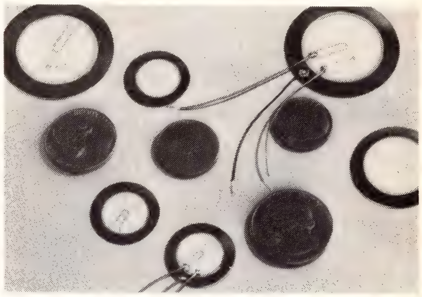


Teledyne Crystalonics, 147 Sherman St., Cambridge, MA 02140. (617) 491-1670.

CIL350 series regulating diodes handle currents from 11 to 50 mA with peak operating voltages of 45 V. Tempco is low, typically 600 ppm/°C from −55 to +25 and 220 ppm/°C from +25 to +125 C. The diodes come in hermetically sealed, two-lead TO-5 cans. The devices work as stable current references for TC zeners, to provide high stability biasing for oscillators and for protection for ICs.

CIRCLE NO. 359

Piezo alarms sound off in clocks, calculators



Murata, 1148 Franklin Rd., S.E., Marietta, GA 30067. (404) 952-9777.

A line of piezoelectric audio alarms generate high outputs at relatively low power inputs. The devices are suited for used in low-power semiconductor circuits, such as watches, calculators, data processing units and telephones. The units are offered with or without feedback tabs and can be externally excited or self-excited as the application dictates. Leaded and unleaded versions are available. Typical dimensions range from 200 to 35 mm diameter with an overall thickness of approximately 0.5 mm. Resonant frequencies range from 2.2 to 6.3 kHz with a maximum input voltage rating of 30 V pk-pk.

CIRCLE NO. 360

DOSC Introduces

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THE MOST POWERFUL MICROCOMPUTER AVAILABLE TODAY!

TCB-85/
Total Computer Board

48K RAM (64K optional) with sockets available for up to 16K PROM

Strobed or Scanned Keyboard Interface

Serial I/O Port

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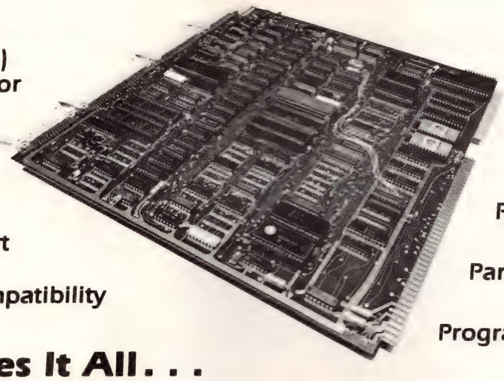

Dual-Density/Double-Sided Floppy Disk Controller

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One Board Does It All . . .

Complete as a stand-alone or used with Intel's Multibus™, the TCB-85 combines outstanding performance and reliability with an impressive variety of features. . .all in one compact, low priced package.

In addition to an extremely powerful I/O capability and high level of integration, the TCB-85 is capable of supporting CP/M and PASCAL with DOSC PROMs.

The TCB-85 uses the Intel 8085A CPU and can optionally be ordered with the Intel 8085A-2/10 MHz CPU.

TM Trademark Intel Corporation

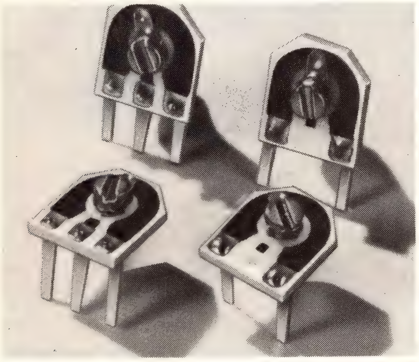
Evaluation units are now available for immediate delivery and priced at just $1275 in quantities of 100.

Get All the Details Now!
Contact Alex Newman at (516) 621-6640

DOSC
OEM PRODUCTS DIVISION
175 I.U. Willets Road, Albertson, NY 11507

CIRCLE NUMBER 107

Micromini trim pots measure 1/4 in. on a side



Murata, 1148 Franklin Rd. S.E., Marietta, GA 30067. (404) 952-9777.

Microminiature trimming potentiometers, RVA 0607 Series, measure only 1/4 in. on a side. The parts are offered in resistance ranges from 200 Ω to 2 MΩ and with 30% tolerance. Power rating is 1/10 W; voltage rating, 50 V dc. Standard resistance taper is linear over the unit's full 280° rotation.

CIRCLE NO. 361

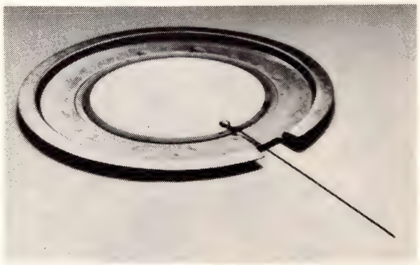
500-V MOSFETs handle high-power jobs

International Rectifier, 233 Kansas St., El Segundo, CA 90245. (213) 772-2000. $18.20 to $30.40 (TO-3); $12.00 to $27.40 (TO-220) (100 qty).

High-voltage MOSFETs, additions to the HEXFET line, go to work in motor controls, inverters, choppers, audio amplifiers and high-energy pulse circuits. IR430 and IR830 series devices cover a 60 to 500-V range and offer such advantages over bipolar devices as voltage control, high input-impedance, fast response, freedom from secondary breakdown and easy paralleling. Electrical characteristics include a minimim gate threshold voltage of 1.5 V, a typical off-state drain current of 0.1 to 0.2 mA and a forward transconductance of 1.5 to 2.5 S. Input capacitance is typically 700 pF. The highest rated device in the series is the IRF 430 which operates at 500 V with a continuous drain current of 3.5 A or a pulsed current of 6 A. On -resistance is 1.5 Ω. Maximum power dissipation for all devices is 75 W. TO-3 and TO-220AB packaging are available.

CIRCLE NO. 362

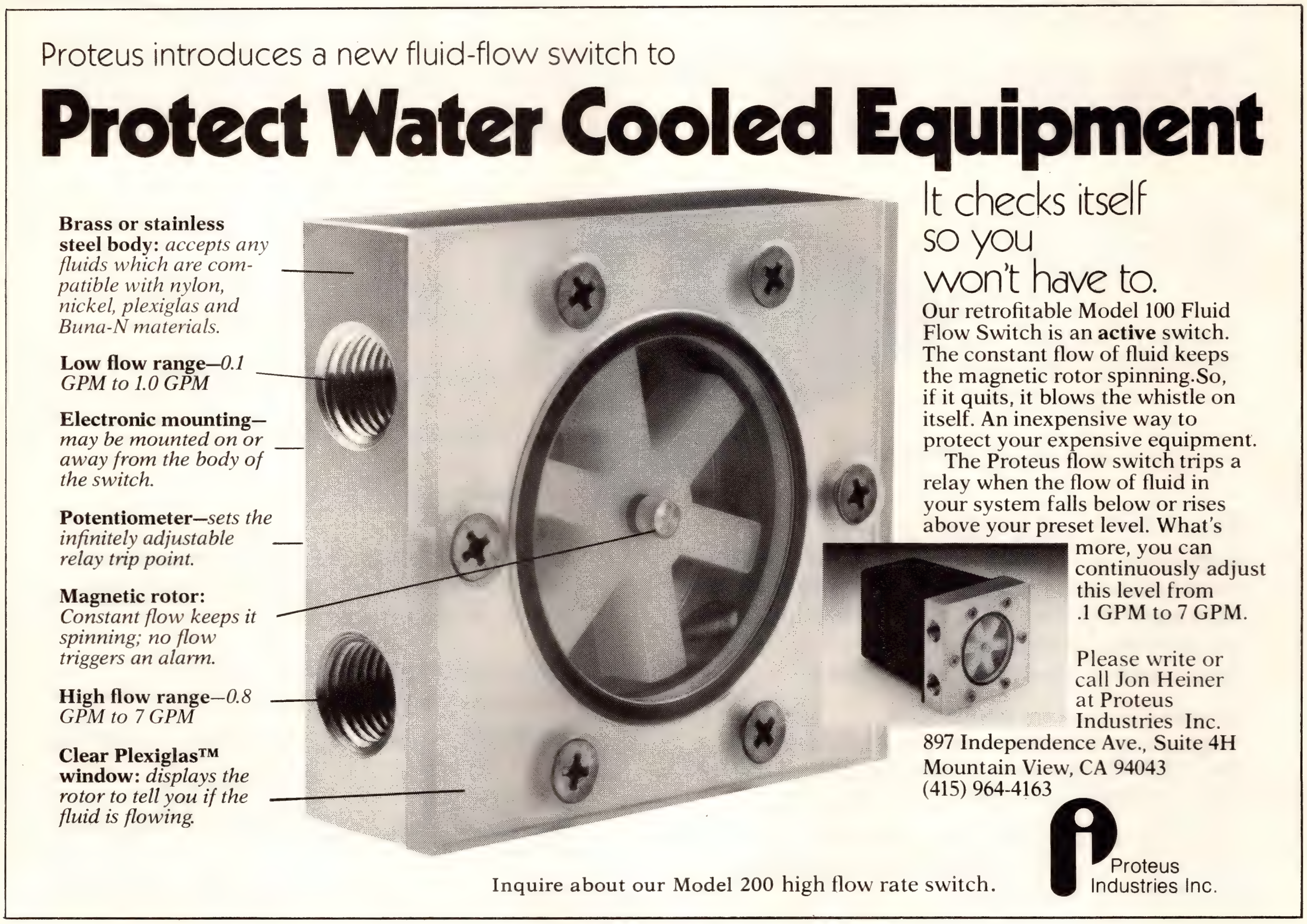
Piezo ceramic buzzer generates multitones



Panasonic, One Panasonic Way, Secaucus, NJ 07094. (201) 348-7282. $0.40 to $0.50 (OEM qty); 8 to 13 wks.

A piezoelectric ceramic buzzer element, EFB-S19A01CE, generates a number of tones, depending on the applied signal frequency. When driven by a 10-V pk-pk square wave, the element produces a sound pressure level of 80 to 95 dB over a range of 500 to 5000 Hz at a distance of 10 cm. Resonant frequency is 1.9 kHz; resonant impedance, 480 Ω maximum; electrostatic capacitance, 70,000 pF at 0.12 kHz. The device operates from a 6-V pk-pk input. Dimensions are 35 mm by only 1 mm.

CIRCLE NO. 363



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Protect Water Cooled Equipment

Brass or stainless steel body: *accepts any fluids which are compatible with nylon, nickel, plexiglas and Buna-N materials.*

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Electronic mounting—*may be mounted on or away from the body of the switch.*

Potentiometer—*sets the infinitely adjustable relay trip point.*

Magnetic rotor: *Constant flow keeps it spinning; no flow triggers an alarm.*

High flow range—*0.8 GPM to 7 GPM*

Clear Plexiglas™ window: *displays the rotor to tell you if the fluid is flowing.*

It checks itself so you won't have to.

Our retrofitable Model 100 Fluid Flow Switch is an **active** switch. The constant flow of fluid keeps the magnetic rotor spinning. So, if it quits, it blows the whistle on itself. An inexpensive way to protect your expensive equipment.

The Proteus flow switch trips a relay when the flow of fluid in your system falls below or rises above your preset level. What's more, you can continuously adjust this level from .1 GPM to 7 GPM.

Please write or call Jon Heiner at Proteus Industries Inc.
897 Independence Ave., Suite 4H
Mountain View, CA 94043
(415) 964-4163

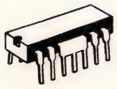
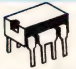
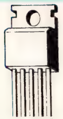
Inquire about our Model 200 high flow rate switch.

Proteus Industries Inc.

CIRCLE NUMBER 106

Don't settle for words when you need audio power amplifiers. Call Sprague.

We do more than talk about deliveries when you order audio power amplifiers. We deliver them. The table below gives you a preview of types currently available:

PACKAGE	TYPE	V_{CC}	P_{OUT} (typ.)	TYPICAL APPLICATIONS	ENGINEERING BULLETIN
 14-lead DIP	ULN-2274B ULN-2274B-1 ULN-2278B ULN-2278B-1	9-22V 9-22V 9-26V 9-26V	1.5W >1.5W 2.5W >2.5W	Dual amplifiers for stereo phonographs & radios; industrial equipment	27117.05D
	ULN-2280B ULN-2281B	9-26V 9-32V	2.5W 4.0W	Consumer, automotive, & communication products	27117.11
 8-lead DIP	ULN-2283B ULN-2283B-1	3-15V 3-18V	1.2W 1.2W	Low cost phonographs & radios (battery operated)	27117.21
 5-lead TO-220	ULX-3701Z ULX-3702Z	8-28V 8-40V	10W 10W	Auto radios, tape players, & CB sets	27117.31

For Engineering Bulletins on the types in which you are interested, write to: Technical Literature Service, Sprague Electric Company, 347 Marshall St., North Adams, Mass. 01247.

For application engineering assistance, write or call Roger Mailloux or Ray Dewey, Sprague Electric Company, Semiconductor Division, 115 Northeast Cutoff, Worcester, Mass. 01606. Telephone 617/853-5000.

For the name of your nearest Sprague Semiconductor Distributor, write or call Sprague Products Company Division, North Adams, Mass. 01247. Telephone 413/664-4481.

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CIRCLE NUMBER 98

HP announces a way to accelerate microcomputer development…

HP—When you depend on logic

and have a little fun while you're at it.

At last, there's a universal development system that frees you from mundane development tasks and lets you concentrate on challenging software and hardware problems . . . HP's 64000 Logic Development System. It brings minicomputer programming features to microcomputer development for faster, easier and more enjoyable software development, hardware emulation and system analysis. And because it's a universal system, you can use it with today's most popular microprocessors.

✓ - MICROPROCESSORS NOW SUPPORTED BY HP's 64000

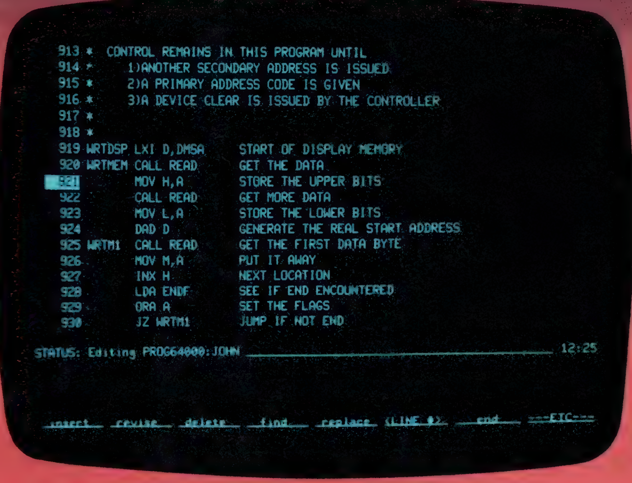
Microprocessor	Full Support*	Macro Assembler Support	Microprocessor	Full Support*	Macro Assembler Support
1802		✓	8085	✓	
6800	✓		9900/9940/9980		✓
6801/6802		✓	F8/3870		✓
6805		✓	Z80	✓	
6809		✓	8086		
8021		✓	68000		
8022		✓	Z8000		
8035/8039		✓			
8041/8741		✓			
8048/8748		✓			
8049		✓			
8080	✓				

*Includes macro assemblers, linkers, emulation and analysis.

Put your fingers on a "soft key"

One of the system's key features is its ability to help you make decisions. At power up, for example, soft keys (keys whose functions are defined by CRT labels) give you a choice of 17 development functions, including edit, compile, assemble, link, emulate, PROM program and more. Pressing the edit key and typing in the name of a previously stored file result in a program listing and soft-key choices that simplify program editing, (shown above right). The CRT even flashes momentary directed-syntax messages to guide you in proper command entry.

The combination of minicomputer power and directed syntax using soft keys means you spend less time memorizing syntax, referring to instruction manuals, doing routine searching and entering line-by-line program changes. The 64000 handles most of those routine tasks so you can concentrate on the real problems. And that's true in assembling, linking, emulating and other development modes as well.



```
*  CONTROL REMAINS IN THIS PROGRAM UNTIL
*     1)ANOTHER SECONDARY ADDRESS IS ISSUED
*     2)A PRIMARY ADDRESS CODE IS GIVEN
*     3)A DEVICE CLEAR IS ISSUED BY THE CONTROLLER
*
*
WRTDSP LXI D,DMSA     START OF DISPLAY MEMORY
WRTMEM CALL READ      GET THE DATA
       MOV H,A        STORE THE UPPER BITS
       CALL READ      GET MORE DATA
       MOV L,A        STORE THE LOWER BITS
       DAD D          GENERATE THE REAL START ADDRESS
WRTM1  CALL READ      GET THE FIRST DATA BYTE
       MOV M,A        PUT IT AWAY
       INX H          NEXT LOCATION
       LDA ENDF       SEE IF END ENCOUNTERED
       ORA A          SET THE FLAGS
       JZ WRTM1       JUMP IF NOT END

STATUS: Editing PROG64000:JOHN ______________________________ 12:25
```

Work with a friend . . . or five

With HP's 64000, serial development is a thing of the past. Now, up to six team members can do software development and/or real-time emulation simultaneously. And each has immediate access to the latest version of software. That's because the 64000 has a hard disc that provides a common data base for all operators.

To assure accurate, real-time emulation, the 64000 has separate buses and memory for both the host and target processors. In addition, we use high-speed memory. As a result, there's no contention problem and your system runs at operating speed with no wait-states.

Of course there's much more to the 64000, including a wide choice of PROM programmers, up to 128K of emulation memory, an optional analyzer that gives you a real-time, transparent view of bus activity, and architecture powerful enough to adapt to future processor trends such as increased speed and bus width. Price for a minimum operating system is $18,500.*

Find out how much fun microcomputer development can be. For a copy of the HP 64000 brochure, write to Hewlett-Packard, 1507 Page Mill Road, Palo Alto, CA 94304. Or call the HP regional office nearest you: East (201) 265-5000, West (213) 970-7500, Midwest (312) 255-9800, South (404) 955-1500, Canada (416) 678-9430.

*Domestic U.S.A. price only.

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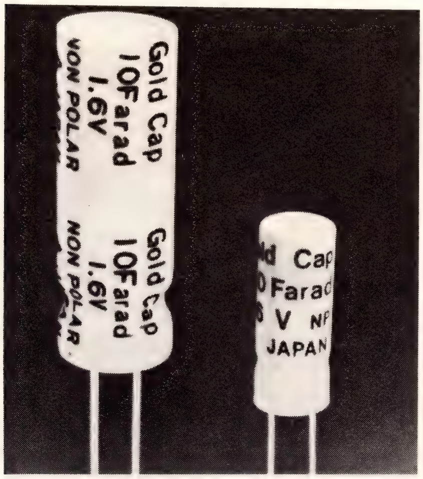
CIRCLE NUMBER 38

High-value caps top 100 F in circuit-board size parts



Panasonic, One Pansonic Way, Secaucus, NJ 07094. (201) 348-7270. Stock to 12 wks.

Extremely high capacitance values, from 1 to 100 F, are offered in circuit-board size units called "Gold Capacitors." A 10-F capcitor, for example, measures only 1.46 in. long and has a diameter of only 0.51 in. Specifications for a 10-F unit include a WVDC of 1.6 V, a tolerance of ±20%, internal impedance of 1 Ω at 1 kHz and 20 C, a minimum leakage current of 1 mA after 10 min. at rated WVDC and an operating temperature range of −20 to +70 C. High capacitance values are achieved via a proprietary technique based on the use of a liquid electrolyte and double-layer foil.

CIRCLE NO. 364

Opto-coupled ac relay takes logic-level input

Power Interface, 3350 Scott Blvd., #34, Santa Clara, CA 95051. (408) 727-1991. $4.51 (1000 qty); stock to 6 wks.

An optically coupled ac solid-state relay (SSR), designated SK2110, accepts logic-level 5-V inputs. The input uses a GaAs LED while the output contains two back-to-back SCRs. The circuit operates at zero voltage turn-on and zero current turn-off of the SCRs. High immunity is provided against transients in the ac load circuit. Off-state blocking voltage is 400 V; dv/dt rating, 100 V/µs; input-to-output isolation, 2500 V ac. Continuous output rating is 0.5 A. The device comes in an 8-pin epoxy DIP.

CIRCLE NO. 365

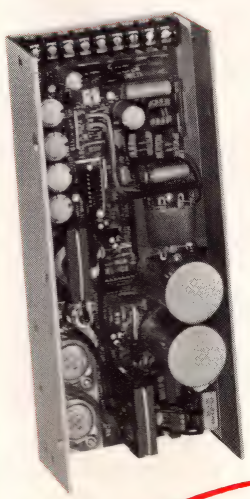
Conductive plastic pot bests carbon types

Bourns Controls, 1200 Columbia Ave., Riverside, CA 92507. (714) 781-5305. $0.91 (5000 qty); 12 to 14 wks.

An industrial-grade control potentiometer, Model 91/92, uses a conductive plastic element for good performance at the cost of lower performance carbon types. The parts measure only 5/8 in. on a side and come with pin terminations for PC-board mounting or solder lugs. The resistive element is formed on a substrate of Ryton or diallyl-phthalate plastic. Contact resistance variation is specified at ±1% maximum for linear and audio tapers. Standard tolerance is ±20%, with ±10% optional. Tempco is within ±1000 ppm/°C over a −55 to +125-C range. Resistance change resulting from humidity soak is less than ±10%. Standard resistance values range from 250 Ω to 5 MΩ in linear-taper devices and from 1 kΩ to 1 MΩ in audio-taper versions.

CIRCLE NO. 366

DELTRON SWITCHERS are NO GLITCHERS



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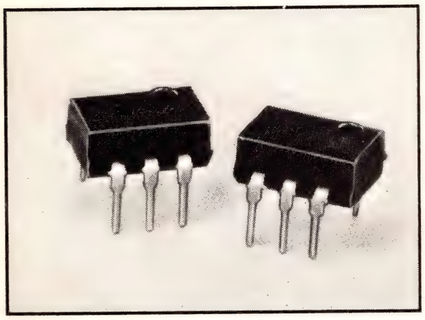
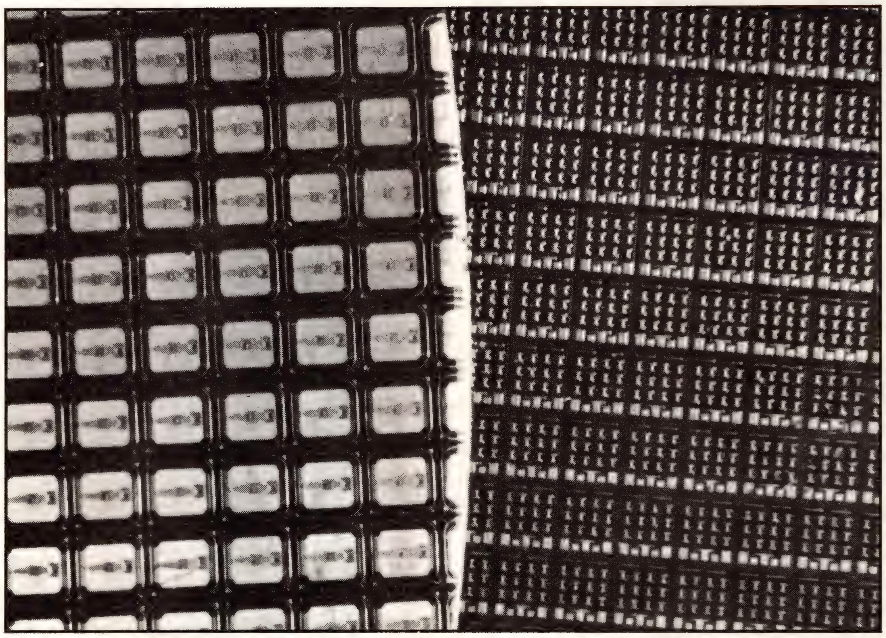
AC34

CIRCLE NUMBER 77

Power-MOS solid-state relays respond quickly to TTL signals





Theta-J Corp., 208 W. Cummings Park, Woburn, MA 01801. Al Mulica (617) 935-7600. P&A: See text.

A new family of solid-state relays harnesses the fast switching speeds of power-MOS devices to the high isolation of optocouplers. Just introduced by Theta-J (Electronic Design, March 29, 1980, p. 60), the OptoMOS family of SSRs will respond within 0.1 ms to low-level TTL signals and will switch high-voltage and current loads with minimal on-resistance. The low-cost semiconductor devices keep performing through billions of operations.

The OptoMOS couplers are among the few solid-state switches capable of handling both ac and dc currents. The OptoMOS device, therefore, comes close to being the "universal switch" relay users have been seeking.

The first products from Theta-J to employ the new OptoMOS technology are the OFM-1A, OFM-2A and OFM-2C, in miniature six-pin DIP packages. The OFM-1A responds to TTL signals of approximately 15 mA at 5 V and accommodates loads up to 250 mA at 300 V, ac or dc. The OFM-2A controls higher current loads, up to 500 mA at 60 V. The OFM-2C is similar to the OFM-2A, but it has an unusual SPDT solid-state switching arrangement.

Switching speeds for the SSRs are less than 100 μs max, and, in some cases, as low as 10 μs. Each device can be externally programmed for somewhat different speeds at turn on and turn off. SSRs that turn off slightly faster than they turn on are useful in ATE, IC testing and other applications that require make-before-break contact.

The OptoMOS SSRs provide isolation greater than 2500 V between control and load circuits (though they have been successfully tested up to 5 kV). With full voltage across the load side of the SSR, the off-state resistance is better than 1000 MΩ, which approaches the open-circuit resistance ratings of 10^{11} and 10^{12} Ω of reed relays.

OptoMOS's impressive numbers result from the combination of optocoupling with photovoltaics and power-MOS technology. At the input of the OptoMOS relays, a custom-made high-brightness GaAlAs LED responds to TTL signals at +5 V. The light output is directed through a specially-designed light pipe to a photovoltaic generator.

Sixteen diodes generate about 0.55 V each, producing a 9-V potential to the gate of a vertical DMOS power chip. All the power to drive the dual gates of the output device comes from the 32 diodes in a monolithic 0.040 × 0.080-in. chip (shown in the wafer photo above). Because of its dual-gate structure, the MOSFET chip conducts current in either direction.

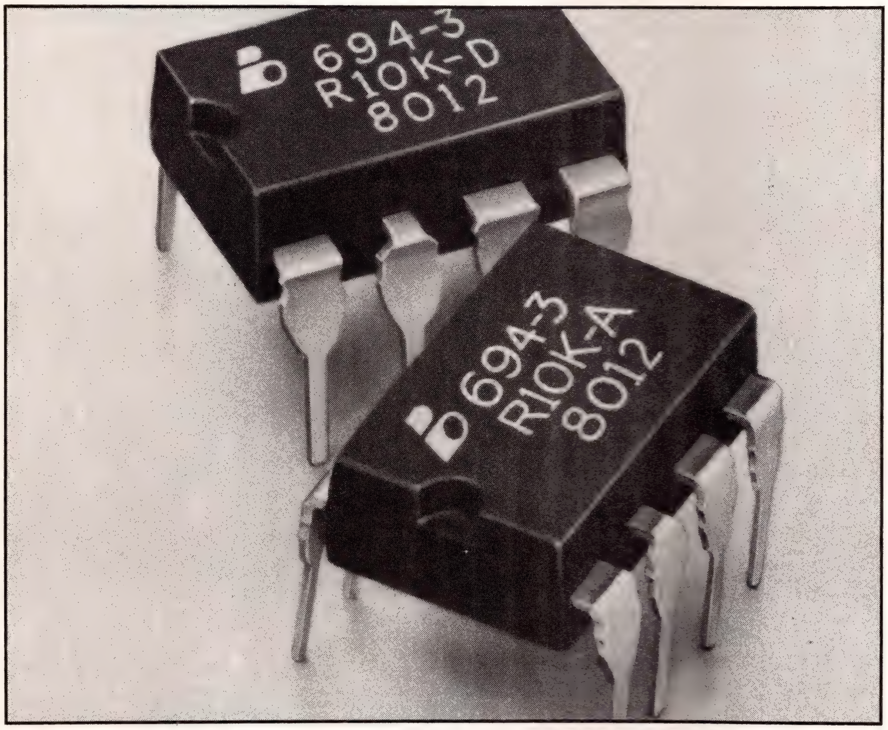
In practice, the OptoMOS devices can replace reed relays in flying-capacitor circuits and other switching configurations on analog I/O boards. Because of their current capabilities, the OptoMOS parts can effectively replace SSRs in telecommunications applications and handle 48-V dc central-office switching. The OptoMOS devices can also enhance the performance of mechanical relays. The OptoMOS part, for example, could perform the fast switching, while the mechanical device carries the sustained load.

In lots of 1000 the OFM-1A and OFM-2A devices are $4.00 each and the OFM-2C devices are $6.00 each. Samples are available from stock, and delivery on production quantities is from four to six weeks.

CIRCLE NO. 317

Stephan Ohr
Components Editor

Thin-film resistor networks set ADC input range



Beckman Instruments, Inc., Network Products Operations, 2500 Harbor Blvd., Fullerton, CA 92634. Steve Ford (714) 871-4848. P & A: See text.

A series of thin-film resistor networks—each providing four separate high-precision resistors in one miniature 8-pin DIP—is specifically designed to provide input range-setting functions for data converters. Coupled with data converters, the 694-3 networks provide a convenient way to set the analog input range of an a/d converter, or the output gain of a d/a converter.

The four 10-kΩ thin-film resistors in each network are vacuum-deposited with Beckman's proprietary process. Resistance tolerance for each resistor is within ±0.5% for the D networks, and ±0.1% for the A types, both at 26 C. Resistance matching for each resistor is within ±0.1% for the D group and ±0.05% for the A group.

Temperature coefficients for the resistors are better than ±50 ppm/°C. Operating temperature range is from −65 to +125 C. Interlead capacitance is less than 2 pF, while power-handling capability is up to 0.15 W for each resistor and up to 0.5 W for the entire package. In addition, each resistor has a voltage rating of 100 V.

Needless to say, thin-film resistors produce very little noise: The noise level of the 694-3 series networks, in fact, is better than 40 dB below the signal level, as measured according to MIL-STD-202, Method 308.

In fact, all the figures for the 694-3 networks are impressive. MIL-R-83401 establishes the limits of resistance shift under a variety of environmental conditions: ±0.25% max shift after thermal shock; 0.5% max shift after power conditioning; 0.1% max shift after low-temperature operation and 0.1% max shift after short-term overload. Other numbers include 0.4% max shift after high moisture; 0.25% max shift after shock or vibration and 0.2% max shift after high temperature exposure.

Prices are $1.05 each in lots of 1000 for the D networks, and $1.55 each for the A networks. Delivery is stock to six weeks.

CIRCLE NO. 310

Now...
the only
RF power
amplifier you
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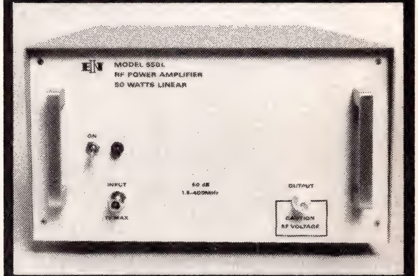
The new ENI 550L
delivers 50W, 1.5-400 MHz.



This single unit is so incredibly versatile it can replace several you may be using now. And you may never need another. It's an extremely broadband high power, solid state, Class A linear amplifier. It's rated at 50W from 1.5-400 MHz. But it can provide 100 Watts from 1.5-220 MHz. All you need with the 550L is any standard signal or sweep generator and you've got the ultimate in linear power for such applications as RFI/EMI testing, NMR, RF Transmission, ultrasonics and more.

And, like all ENI power amplifiers, the 550L features unconditional stability, instantaneous failsafe provisions, and absolute protection from overloads and transients.

The 550L represents the pinnacle in RF power versatility. There's nothing like it commercially available anywhere! And it may be the only RF power amplifier you ever need.

For more information, a demonstration, or a full line catalog, please contact us at ENI, 3000 Winton Road South, Rochester, NY 14623. Call 716/473-6900, or telex 97-8283 ENI ROC.

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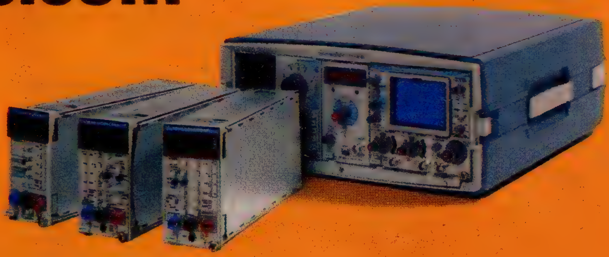
CIRCLE NUMBER 157

Three new TM 500 Digital Multimeters give you more performance choice...

from Tektronix.



Introducing:

- **DM 501A**
  4½ digits, true rms, dB, .05% accuracy, seven functions.
- **DM 502A**
  3½ digits, true rms, autoranging including dB, seven functions.
- **DM 505**
  3½ digits, five functions.

We've put the best combination of accuracy and convenience into compact, affordable DMM's. Simply put them to the test. These versatile DMM's are at home everywhere, making your electronics tests faster and easier.

Choose seven function capability, including dB and temperature, from the new DM 501A and DM 502A. Increase your accuracy with the 4½ digit DM 501A, featuring true rms capability and 10 μV resolution. The 3½ digit DM 502A features autoranging in voltage, resistance, and dB, plus true rms capability. Add the all-around testing capabilities of our low-cost DM 505, and you've got a digital multimeter for practically every purpose.

They're all part of the TM 500 family. Just plug them into any TM 500 Mainframe to make on-site, rack, or bench measurements. Combine them with any other TM 500 instruments to build a compact test set just right for your application.

And, there's even more to these new DMM's. They give you Tektronix reliability, too. Add TM 500 configurability and modularity, and you get more testing clout for your dollar.

To learn more about these new TM 500 Digital Multimeters, contact the Tektronix Field Office nearest you. For a copy of our TM 500 Digital Multimeter Data Sheet, call our toll-free, automatic answering service: 1-800-547-1512. In Oregon, call collect: 644-9051. Or, send your request on your letterhead to Tektronix, P.O. Box 500, 76/260, TM 500 B7, Beaverton, OR 97005. In Europe: Tektronix International Inc., European Marketing Centre, Postbox 827, 1180 AV Amstelveen, The Netherlands.

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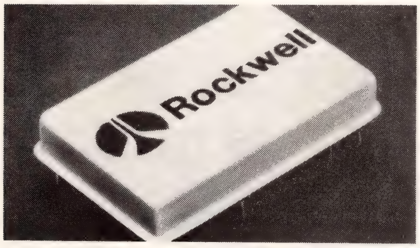
SAW delay lines end tuning problems



Rockwell International Filter Products, 4311 Jamboree Rd., Newport Beach, CA 92660. (714) 833-4324.

A family of surface acoustic-wave (SAW) dispersive delay lines (DDLs) eliminates the complex tuning procedures associated with other techniques. The devices come with center frequencies of 30 to 300 MHz and bandwidths of 10 to 50%. Differential time delays are 0.5 to 20 μs. Applications include radar, microscan receivers, frequency synthesizers, ECM receivers and spread spectrum communication systems.

CIRCLE NO. 367

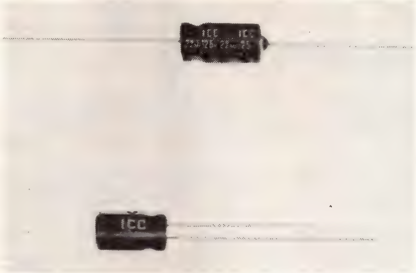
Image intensifier tube helps night vision

ITT Electro-Optical, 7635 Plantation Rd., Roanoke, VA 24019. (703) 563-0371. 4 to 13 wks.

A family of image intensifier tubes, Generation III, assists low light-level night vision. The tubes are small and lightweight, making them particularly desirable for use in head or helmet-mounted night vision goggles. The tubes consist of a GaAs photocathode bonded to a type 7056 glass input window. Also included is a microchannel plate current amplifier and a phosphor screen. The photocathode is most sensitive to a low light-level or infrared image in the 580 to 920-nm region.

CIRCLE NO. 368

Aluminum capacitors fit where space is tight



International Components, 105 Maxess Rd., Melville, NY 11747. (516) 293-1500. From $0.044; stock to 10 wks.

PDB and TDB aluminum capacitors come in miniature sizes to fit onto crowded circuit boards. Case size is as small as 0.197-in. diameter by 0.433-in. long. Capacitance range is 0.47 to 10,000 μF with a tolerance of ±20%. Leakage current is only 3 μA. Both axial and radial lead versions are available.

CIRCLE NO. 369

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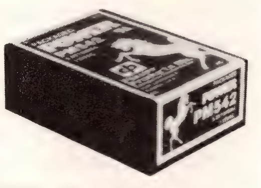

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PM396

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(*OEM quantity price)

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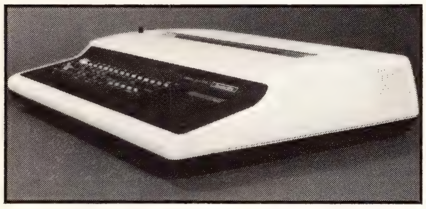
CIRCLE NUMBER 100

Peripherals

Compact matrix printers employ blade-mounted pins—quietly



General Electric Co., Data Communication Products Business Dept., Waynesboro, VA 22980. (703) 949-1000. P&A: See text.

The Terminet 2000 impact-printer family incorporates a new 7 × 9 matrix print head whose blade-mounted pins ensure less than 60-dB operation.

The printer series, which features a microprocessor-scanned keyboard, includes the 2030, which prints at 30 characters per second and the 2120, which prints at 120 char/s. Both printers are compact—22 × 18.5 × 5.5 in.—and weigh only 22 lb. Underline capability on both models also enhances the print-head operation. What's more, a dc servo-motor-controlled print-head mechanism allows bidirectional printing without fill characters.

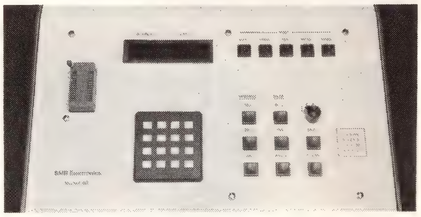
The 2030 also features a 60-char/s catch-up rate, while the 2120 features a 150-char/s rate. Print density can be selected at 10, 13.2 and 16.5 char/in. along a 13.2-in. print line. The ribbon cartridge is stationary, with the ribbon driven by a stepper motor.

Using dual 8085 microprocessors, both printers offer a received-data buffer and feature nonvolatile memory. Using switching type regulators, the units require only 30 W (2030) or 50 W (2120). What's more, both provide a full RS-232C data interface; a 300-baud modem is optional.

The 2030 sells for $1400 (receive only) and the 2120 for $2100 (RO). The 2030 will be available for volume shipments in the third quarter of 1980 and the 2120 in the fourth quarter.

CIRCLE NO. 321

Programmer works on single-supply EPROMs

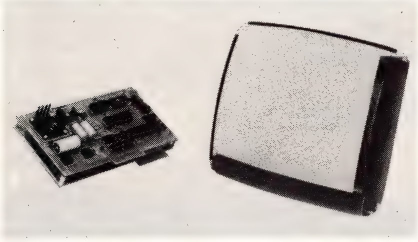


SMR Electronics, 3 Haven Rd., Medfield, MA 02052. Steve Rudnick (617) 359-7697.

A self-contained programmer for single-supply EPROMs, Model 80, both programs and makes copies from a master. The unit works with 2758, 2516, 2716, 2532 and 2732 types. Programs are entered via a panel keyboard of an optional, bidirectional ASCII-Hex serial interface. Extensive editing capabilities are provided for insertion and deletion of data with resequencing prior to programming. The unit accommodates baud rates from 75 to 4800 and comes with 4-k × 8 internal memory, switch-selectable parity stop and bit configurations, RS232 inputs and outputs and a rechargeable battery backup to prevent data loss during power interruption.

CIRCLE NO. 370

Touch screen digitizer fits 12-in. CRTs



TSD Display Products, 35 Orville Dr., Bohemia, NY 11716. (516) 589-6800. $950 to $1200.

A touch-screen digitizer, for fast data retrieval from menu-based video displays, fits 12-in, diagonal CRTs. The touch-screen approach to computer-to-operator interface eliminates need for keyboards and light pens and simplifies computer use for inexperienced operators. The touch screen matches the curvature of most 12-in. CRTs to minimize parallax error and optimize pointing accuracy. The digitizer can be supplied with or without a power supply and RS232 interface.

CIRCLE NO. 371

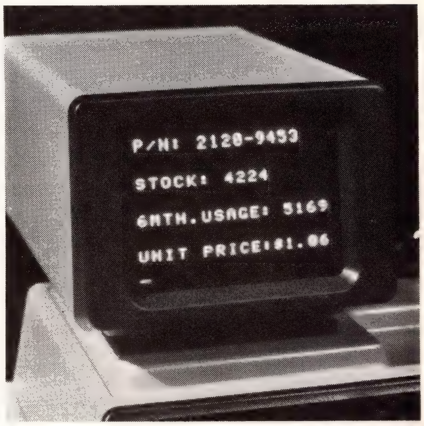
μC-based unit responds with male/female voice

Perception Technology, 95 Cross St., Winchester, MA 01890. (617) 729-0110. From $7000.

A stand-alone voice response system based on a DEC LSI-11 computer, the BT-2, communicates messages, instructions, questions, answers and alarms in telephone-quality male or female speech. A basic configuration comes with eight channels of speech output and approximately 30 words. Maximum configuration has 64 input and 64 output channels and 256 words. Options for the RS232-compatible system include a wide variety of telephone and computer interfaces. Any software that runs on the LSI-11 can run simultaneously with voice response functions.

CIRCLE NO. 372

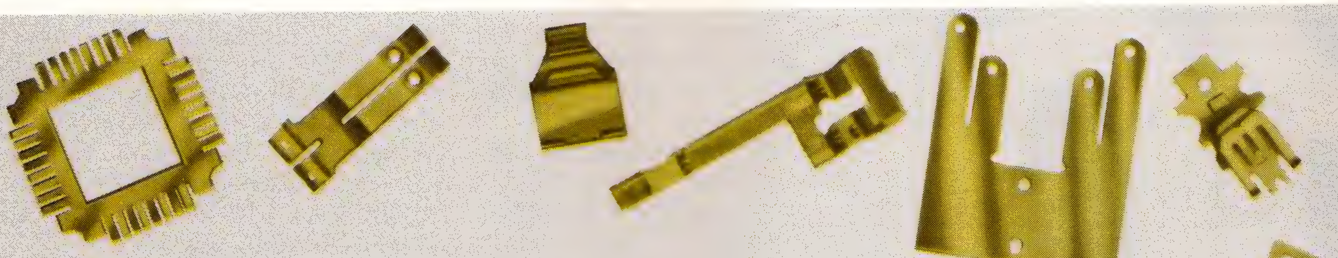
CRT display fits onto data capture terminals



Hewlett-Packard, 1501 Page Mill Rd., Palo Alto, CA 94304. (415) 857-1501. $936; 8 wks.

An option for the firm's data capture terminals, a 5-in. CRT display, gives two styles of video information. A large character-size mode and a special anti-reflective screen assure easy reading. The display fits onto a desktop HP 3075 or the wall-mounted HP 3076 terminals. Sixteen lines, each with 32 normal-size characters, can be shown. In the large character mode, 8 lines of 16 characters can be shown.

CIRCLE NO. 373



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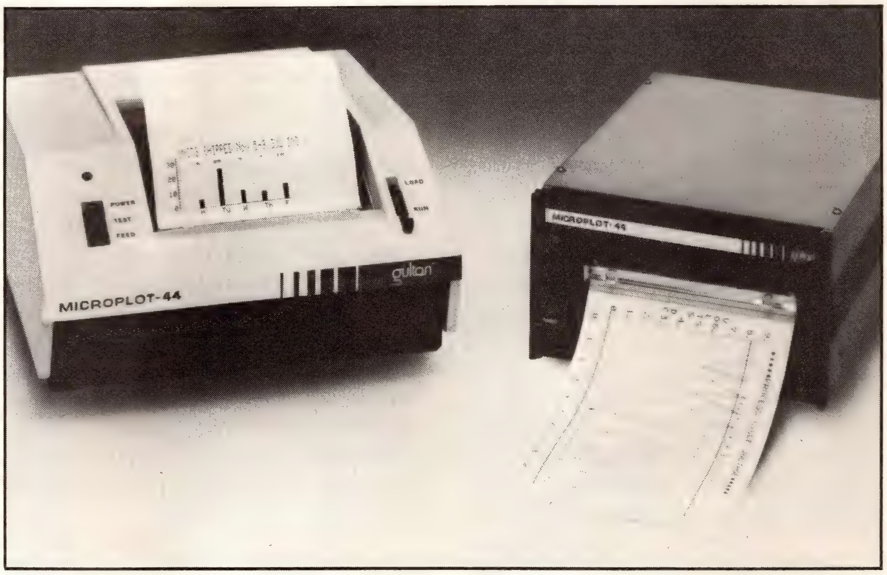
CIRCLE NUMBER 164

10

SEE THE "TOP TEN" IN THIS ISSUE

Sophisticated plotter shrinks size and cost



Gulton Industries Inc., Measurement and Control Systems Div., Gulton Industrial Park, East Greenwich, RI 02818. John Olobri (401) 884-6800. P&A: $900; 90 days.

A versatile, low-cost thermal printer/plotter developed by Gulton Industries provides crisp 256-dot resolution in 44 columns. The Microplot-44 is one of the few thermal printers which provide individual dot addressing in a small package for less than $1000.

Using any one of 96 ASCII character codes, the device transforms digital information into alphanumerics or graphics on a 44 × 22-character X-Y plot. The printer also can describe double-height and double-density ASCII alphanumeric characters. Abscissa and ordinate limit tabs are programmable. The Microplot-44 is equipped with a bus-organized parallel graphics interface, compatible with IEEE-488, RS-232C, or OEM parallel buses.

A bit-parallel/byte-serial interface, μC bus-organized, links the printer/plotter to microprocessor control. Data are loaded into the Microplot-44 memory one dot at a time in the plot mode, or one character at a time in the print mode using this interface. The printer/plotter's interface is organized into three data buffers: a 256 byte buffer for plot data, a 44-byte buffer for X-axis character data, and a 22-byte buffer for Y-axis character data. This versatile buffering scheme allows the user to conduct simultaneous plotting, X-Y printing and annotating operations.

Since the plot buffers hold 256 data bytes, each corresponding to a single dot location on the printhead array, each dot is individually addressable. There is no need, therefore, to load blank data to map out spaces, although horizontal vectors can be quickly specified simply by entering their origin and value of magnitude; the printer will automatically fill-in lines between the end points of a horizontal vector, in the enhanced plotting mode.

In addition to programmable or manual mode selection, the Microplot-44 also provides internal self-test, as well as quiet fixed-head thermal operation.

The Microplot-44 will be available in two versions: a desk-top printer/plotter, and a front panel-mounted unit for test instrumentation, industrial process controls and other OEM applications. **CIRCLE NO. 323**

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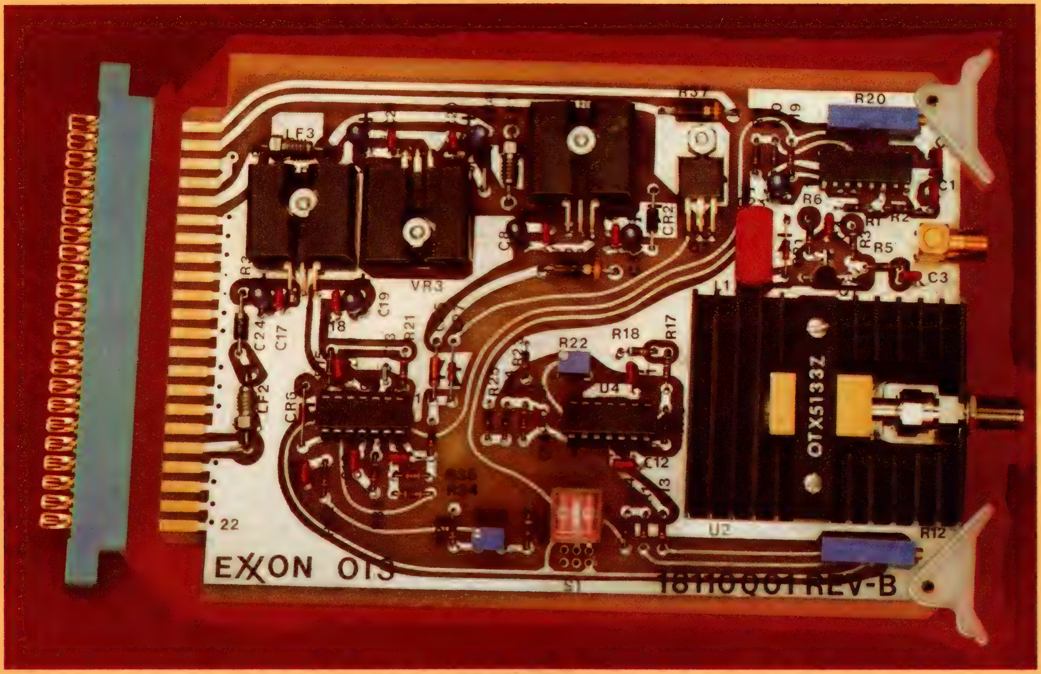

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CIRCLE NUMBER 95

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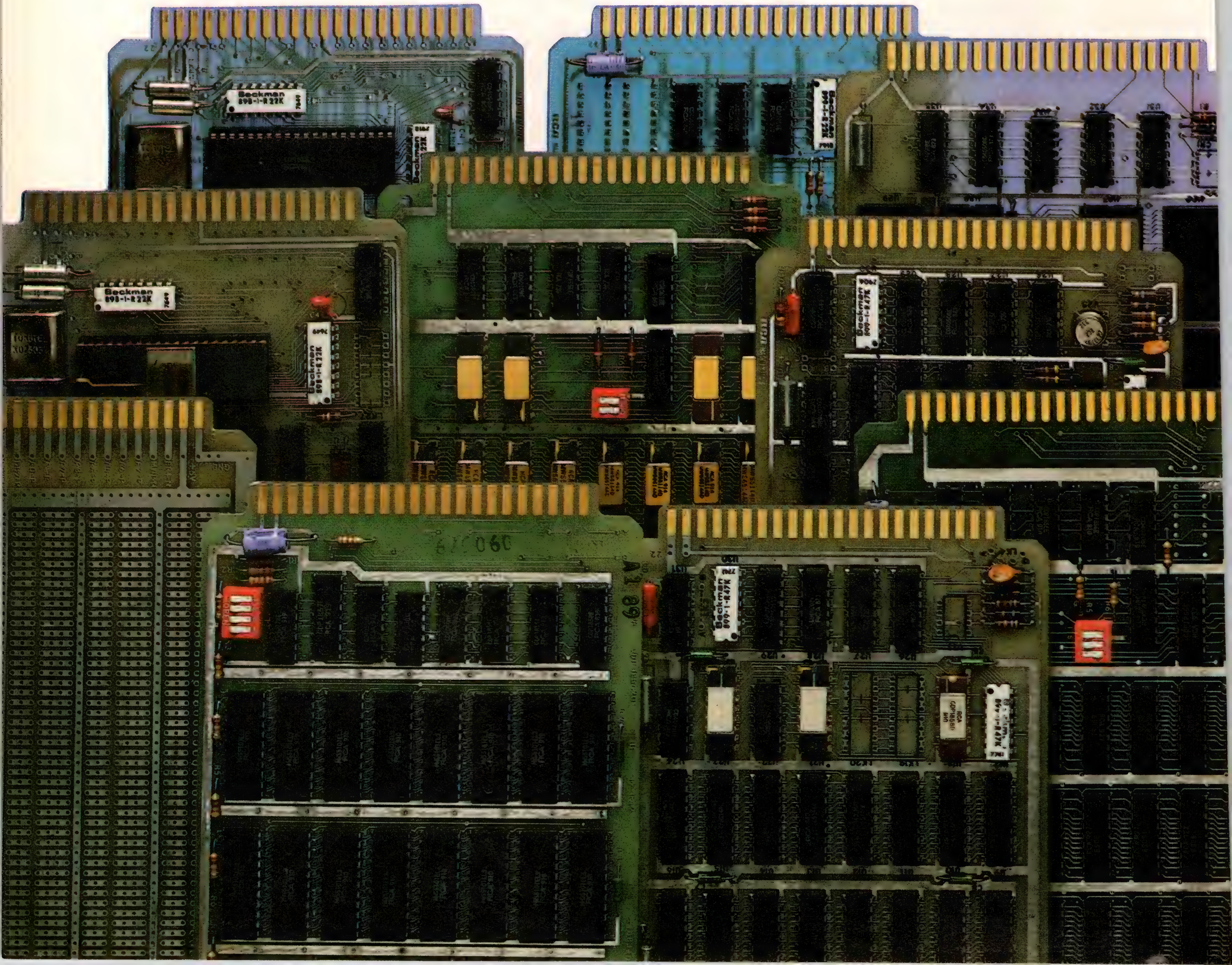
CMOS takes another giant step against NMOS.

RCA adds 12 new Microboards now, 7 more by the end of 1980.



RCA CMOS Microboards consume far less power (7.0 milliamperes), give off far less heat, and provide more functions in less space (4.5 x 7.5 inches) than any NMOS board on the market. And at competitive prices.

With 17 boards available now (24 by 4th quarter 1980) plus a range of chassis and accessories, RCA can provide a CMOS system to suit a wide variety of applications.

Microcomputer boards.

CDP18S601	Microboard Computer w/4K CMOS RAM, 4K/8K ROM/PROM sockets, serial I/O port, 20 programmable parallel I/O lines
CDP18S602*	Microboard Computer w/2K CMOS RAM, 2K/4K ROM/PROM sockets, UART, parallel I/O port
CDP18S603	Microboard Computer w/1K CMOS RAM, 4K/8K ROM/PROM sockets, serial I/O port, 20 programmable parallel I/O lines
CDP18S604*	Microboard Computer w/512 bytes CMOS RAM, 1K/2K ROM/PROM sockets, parallel I/O port

Memory boards.

CDP18S620	4K Static CMOS RAM
CDP18S621	16K Static CMOS RAM
CDP18S621V1	16K Static CMOS RAM
CDP18S622	8K Static CMOS RAM/ Battery backup
CDP18S623	8K Static CMOS RAM
CDP18S624	4K Static CMOS RAM/ Battery backup
CDP18S625	8K/16K ROM/PROM

Combination memory I/O.

CDP18S660	40 I/O Lines, 2K CMOS RAM, 4K/8K ROM/PROM sockets

I/O boards.

CDP18S640	Control/Display Module
CDP18S641	UART Interface
CDP18S642	12 Bit D/A Converter
CDP18S643	12 Bit A/D Converter
CDP18S644*	8 Bit A/D-D/A Converter
CDP18S646*	Parallel I/O
CDP18S649*	LCD Interface/Display
CDP18S661V1*	Video-Audio-Keyboard Interface
CDP18S661V3*	Video-Audio-Keyboard Interface (PAL Version)

Chassis and accessories.

CDP18S023V1	5 Volt Power Converter (100 V, 50-60 Hz)
CDP18S023V3	5 Volt Power Converter (220 V, 50-60 Hz)
CDP18S480	PROM Programmer
CDP18S502	Extender Card
CDP18S659	Breadboard w/prewired power and ground
CDP18S670*	25 Card Chassis w/power supply
CDP18S675	5 Card Naked Chassis
CDP18S676	5 Card Chassis w/Case

Prototyping systems.

CDP18S691	Microboard Prototyping System with CDP18S601 Computer Board
CDP18S692*	Microboard Prototyping System with CDP18S602 Computer Board

Full design support.

RCA Microboards are backed up by a complete line of hardware and software compatible development systems.

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A complete list of RCA Systems Appointed Distributors appears on the following page.

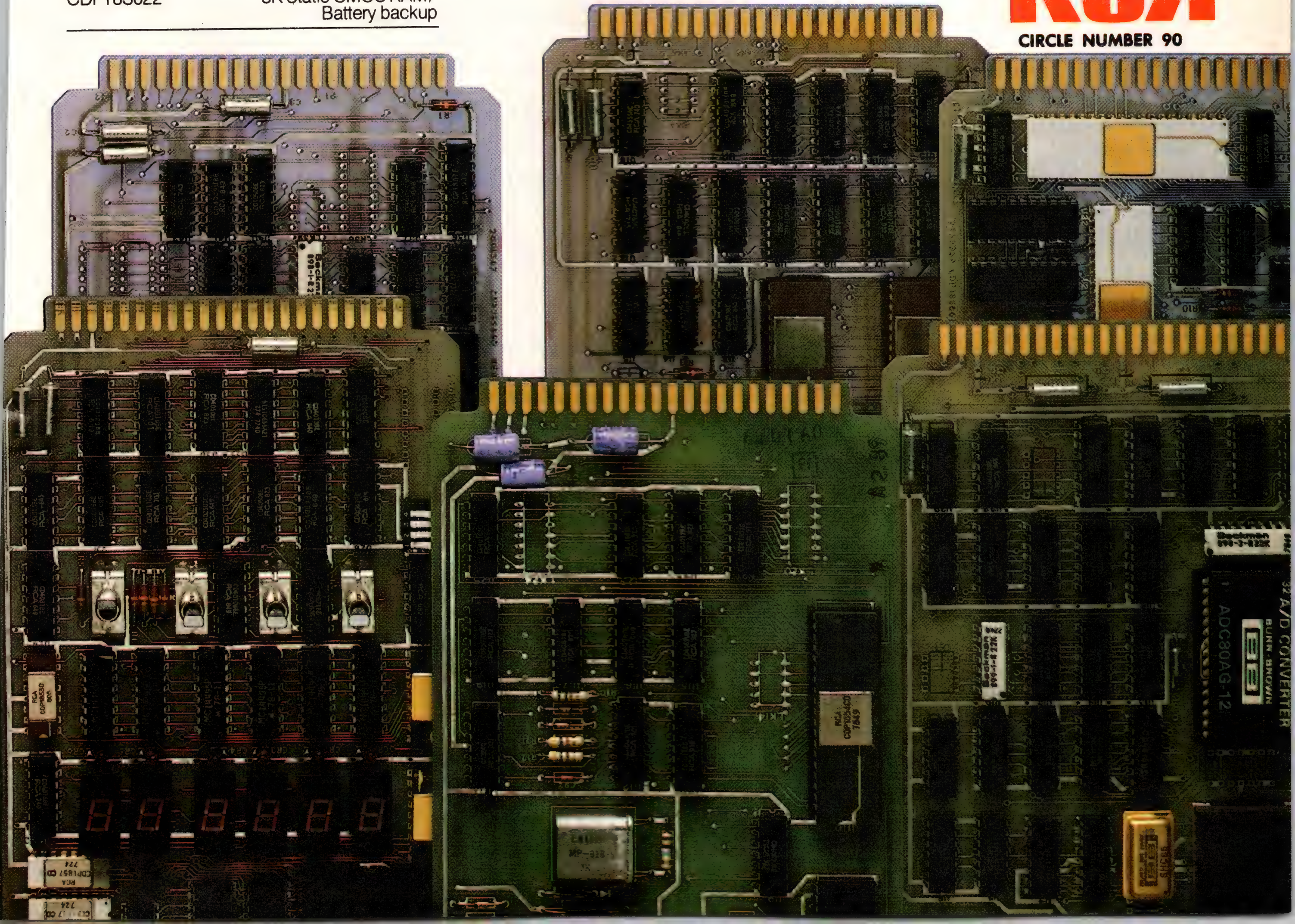
For more information and a free brochure on RCA Microboard Computer Systems, contact your local RCA Distributor.

Or contact RCA Solid State headquarters in Somerville, New Jersey. Brussels, Belgium. Tokyo, Japan.

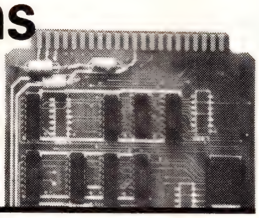
*Coming in 1980

RCA

CIRCLE NUMBER 90



RCA Systems Appointed Distributors.



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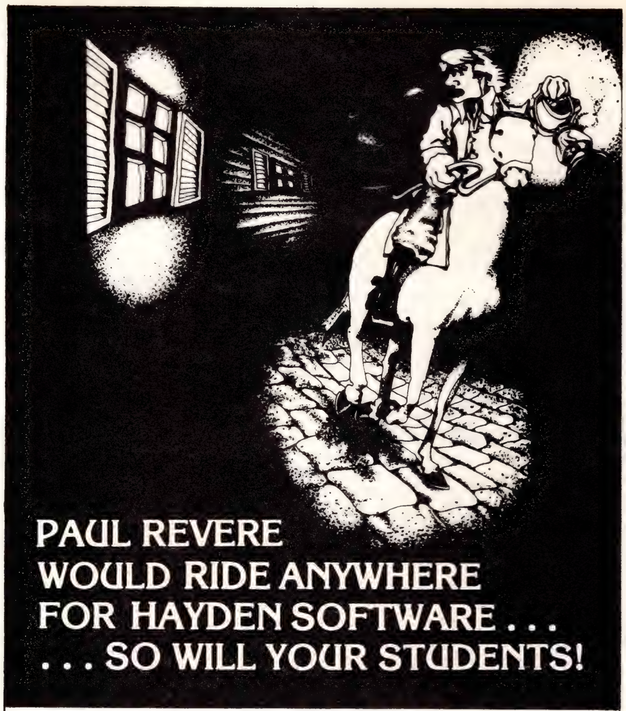
RCA



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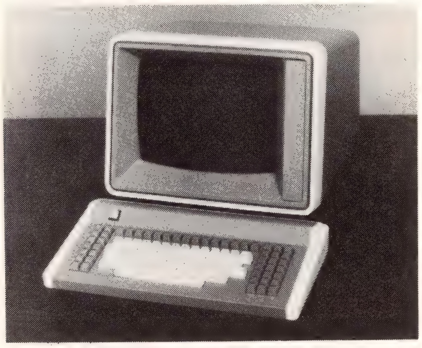

Megadata, 35 Orville Dr., Bohemia, NY 11716. (516) 589-6800. $1500 (500 qty).

Model 850, a programmable terminal, operates as a satellite display unit capable of intelligent, stand-alone functions. A host computer, for example, can be dialed up automatically. The terminal can be automatically called. A separate current loop allows the 850 to assume the receive functions of a telex machine. A transmit loop is optional. The Model 850 includes up to 8-k of PROM for programming, 4-k or 16-k of RAM for buffer and screen storage, a 15-in. display of 80 characters by 25 lines and 4 kbits of optional EAROM. A standard receive and transmit RS232 interface and an RS232 transmit-only printer port are also provided.

CIRCLE NO. 374

Cart drive protects Winchester data

Computer Service Systems Network, 120 Boylston St., Boston, MA 02116. (617) 482-2343. $2995.

BACKUP, a complete hardware/software subsystem, protects disk-stored data, especially data from high-capacity Winchester disk drives. The subsystem uses a 13.4-Mbyte capacity tape cartridge as the storage medium and comes with a Z80A/S-100 compatible interface board and a CP/M compatible software utility. BACKUP permits file-by-file protection. That is, only those files which are lost on a disk can be saved and restored. Earlier, bit-stream backup devices required replacement of all files on a disk to correct an error in only one file. BACKUP comes in a compact, rack-mountable unit.

CIRCLE NO. 375

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CIRCLE NUMBER 82

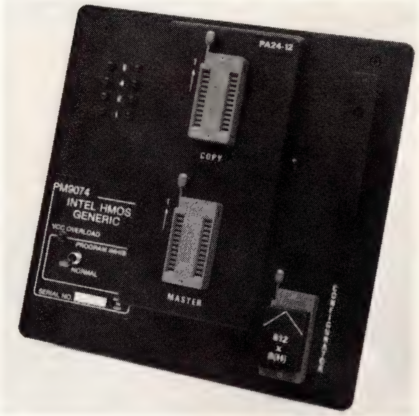
LSI-11 backplane expands terminal into a μC

Digital Equipment, 129 Parker St., Maynard, MA 01754. (617) 897-5111.

A video terminal, VT103, expands into an LSI-11 microcomputer through use of its versatile backplane. The backplane accepts LSI-11 cards, permitting a user to select among a variety of bus-compatible modules. Two versions of the terminal are offered: a basic model, VT103-AA and a unit equipped with a dual-drive DECtape II cartridge subsystem. The terminal's power supply provides 140 W, capable of supporting added modules. The VT103 includes the standard features of its predecessor, the VT100.

CIRCLE NO. 376

Module helps program 2732A EPROMs



Pro-Log, 2411 Garden Rd., Monterey, CA 93940. (408) 372-4593. $550; 6 to 8 wks.

A generic personality module, PM9074, enables all Series 90 PROM programmers to program the high-speed 2732A HMOS EPROM. The module will also accommodate other HMOS EPROMs and higher-density PROMs as they are developed. Plugged into a programmer, the module provides the control lines and timing necessary to list, program, duplicate and verify devices. "Cold sockets" allow installation and removal of PROMs without applying voltage to the devices. High/low verification permits reading of PROMs with the voltage adjusted to its high and low limits. PM9074 contains separate master and copy sockets, programming electronics, pin-out adapters and configurators that automatically adapt the module to the correct bit structure and memory size of each PROM.

CIRCLE NO. 377

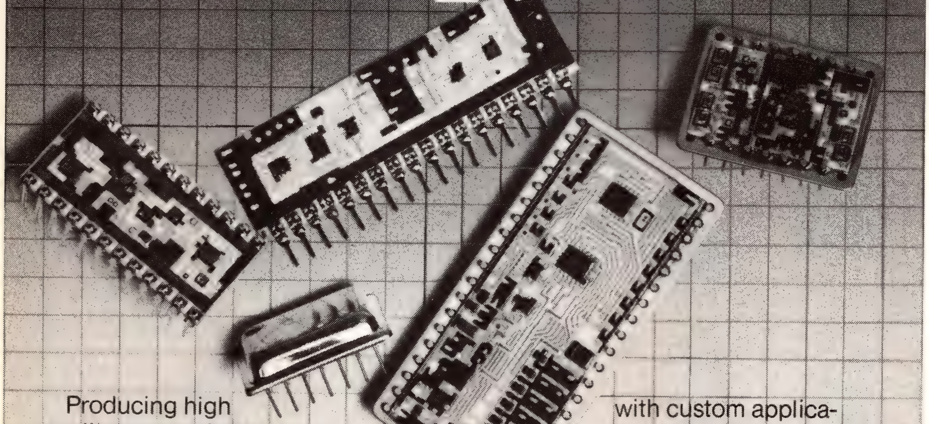
Disk system boosts storage for VAX 11/780

System Industries, 525 Oakmead Pkwy., Sunnyvale, CA 94086. (408) 732-1650. $36,500 (single); $53,900 (dual); 6 to 9 wks.

A disk mass-storage system for VAX 11/780 minicomputers increases memory capacity to 2400 Mbytes of on-line storage. The system emulates DEC's RH780 hardware and RM03 software at the operating system level. The mass storage system includes a 9400 controller, a 300-Mbyte SMD-type disk drive, a synchronous backplane interconnect (SBI) adapter and all connecting cables and hardware. As many as eight drives can be interfaced to a VAX computer in a daisychain configuration.

CIRCLE NO. 378

Practice makes perfect.



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CIRCLE NUMBER 110

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Or write: Mostek, 1215 West Crosby Road,
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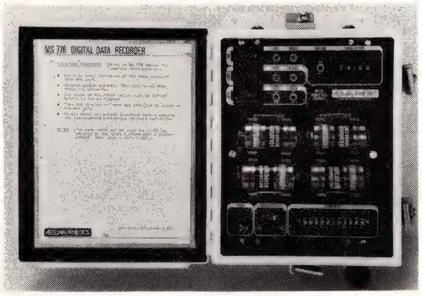
CIRCLE NUMBER 96

Logger stores data at remote sites



Aeolian Kinetics, P.O. Box 100, Providence, RI 02901. (401) 421-5033. P&A: See text.

A portable, battery-powered data logger, MS778, stores data in up to 32-k CMOS RAM at timing intervals from 1 s to 60 h. Data is collected via manual readout on a built-in LED display or through the optional Microcomputer 65, a portable interrogator which produces a paper tape or digital cassette. Remote site data acquisition can be maintained at hourly intervals for up to three months or daily intervals for one year—all totally unattended. Optional input interfaces make the unit compatible with most types of sensors in process control, meteorological and pollution research and traffic counting. A bench model logger costs $695; a water-tight field version, $725. Microcomputer 65 costs $2500 and includes a LED display, thermal printer, ASCII keyboard, cassette recorder, power supply and software within a rugged aluminum carrying case. All items are available in 4 weeks.

CIRCLE NO. 379

Raster scan display eliminates flicker

Lexidata, 215 Middlesex Tpke., Burlington, MA 01803. (617) 273-2700. From $13,087; 13 wks.

Systems 3400, a 1280 × 1024 raster scan display, provides flicker-free refresh at a 60-Hz rate. A high-speed video output stage takes data from memory and converts it to an analog signal. The signal produces a pixel in just 9 ns. The system is intended to replace storage tube and stroke vector technology. The system includes a monitor and an interface to any of a wide variety of host minicomputers.

CIRCLE NO. 380

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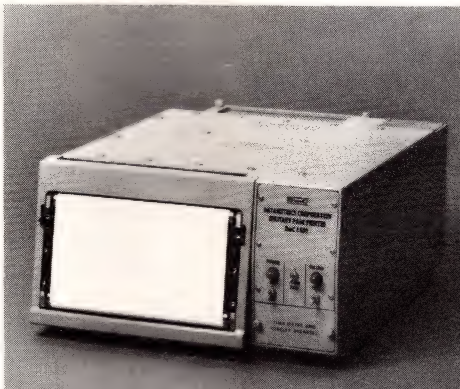
CIRCLE NUMBER 120

THE UNTOUCHABLES



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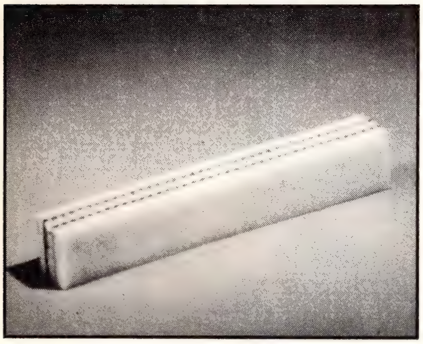
CIRCLE NUMBER 119

Elastomeric connectors forge tight conductive links with little resistance



Conductive Rubber Technology, Olive Mill Plaza, 1230 Coast Village Circle, Santa Barbara, CA 93108. Laurette Bennett (805) 969-5807. $0.20/in. six weeks.

Highly conductive elastomeric connectors from Japan will be especially useful in such low-resistance, small-current application as LCD displays and LSI carrier beds: The HL Type elastomeric connectors from Conductive Rubber Technology (agent for Japan's Shin-Etsu Polymer Co.), employ silver powders in a sponge-rubber bed to provide an unusually low contact resistance of less than $1\ \Omega$.

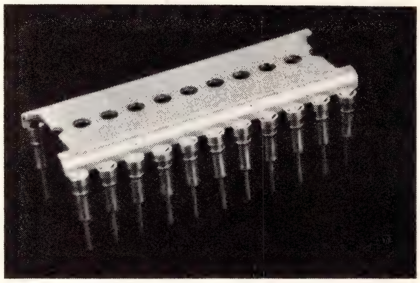
The HL Type elastomer provide gas-tight, highly conductive inter-connections between LCD and PC-board contact pads. Unlike other silver conductors, however, the HL will not tarnish or encourage silver migration between contact pads. They are, in fact, among the only compressible (1 lb/in. for 10% compression) silver conductors available.

Conductive lines are on 0.015-in. centers within the sponge-rubber base. The insulation resistance of the base material is $1.2 \times 10^{12}\ \Omega$ and provides a dielectric strength of 25 KV/mm. Temperature range is −55 to +450 F.

In addition, the elastomeric connectors provide zero-insertion forces and no abrasive contact forces. They are available in lengths up to 7 inches.

CIRCLE NO. 325

Socket carrier inserts terminals fast



Garry Manufacturing, 1010 Jersey Ave., New Brunswick, NJ 08902. (201) 545-2424. $0.85 to $2.25; 2 to 4 wks.

An aluminum lead carrier, Series 940-22, speeds the insertion of 22 socket/terminals into a PC board. The socket/terminals, assembled to the disposable carrier, are Swiss screw-machined parts with gold-over-nickel brass sleeves. A 200 µin. electro-tin finish is available. Four-tine spring socket members are gold-plated beryllium-copper. Dip-solder terminals or 0.025-in. square wrap-wire posts are offered.

CIRCLE NO. 462

Our Little Printers Solve Big Problems

If your system requires a reliable printer but you're short on space, our PR series microprinters are the logical choice. Although we occupy a volume of only 2.3″ H x 5.5″ W x 6.0″ D, we are not short on capability. Consider the features:

- 15 or 21 columns
- Full Alphanumeric
- Impact bar matrix print technique
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- Plain paper
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- Optional DC operation

One thing we *are* short on, however----*price.*

Sodeco manufactures tape and ticket printers, microprocessor-based printer controllers, and printer accessories to suit a variety of applications for the OEM.

For more information on how our little printer can solve your problems call
(914) 592-4400 or
write Sodeco, Div. of
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4 Westchester Plaza,
Elmsford, N.Y. 10523.

SODECO
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CIRCLE NUMBER 104

Telephone patch plugs assemble any length cable

Dynatech, 1225 E. Wakeham St., Santa Ana, CA 92702. (714) 558-8755.

Cross connect Patch Plugs assemble, on site, cables of any length. Wires, of any length, are slipped into the connector and held in place by insulation-displacement contacts. Contacts are gold-plated phosphor-bronze with insulators fabricated of glass-filled polyester in many standard colors. Features include a built-in strain relief, integral plug test points, polarization and a removal tool hole.

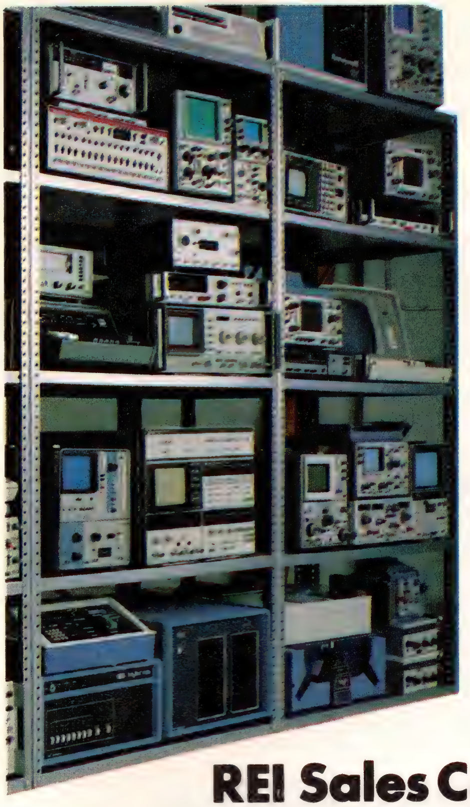
CIRCLE NO. 381

Benchtop system tests for thermal shock

Ransco Industries, 2221 Statham Blvd., Oxnard, CA 93030. (805) 487-7777.

A benchtop liquid thermal-shock system, Model 7205, tests small batches in accordance with MIL-STD 883B, Method 1011.2. Separate hot and cold zone temperature controls and dwell timers allow easy setting of a desired program. A 5-in. diameter, 5-in. high test specimen basket is automatically transfered between hot and cold zones with shut down at the end of a set number of cycles. Hot and cold baths have forced circulation systems for maximum heat transfer. Cooling is provided by liquid nitrogen.

CIRCLE NO. 382



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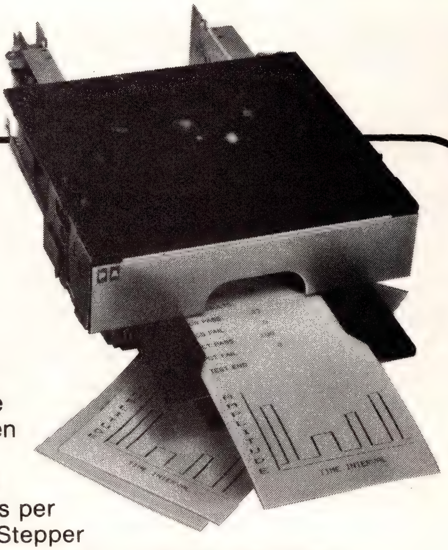
CIRCLE NUMBER 121



Our Alphanumeric Ticket Printer

For total versatility use our DMTP-9 programmable ticket printer to print the full alphanumeric ASCII character set. Print with ribbon on standard tickets, cards or single-sheet forms, or use impact-sensitive paper for multiple copies. Even program character pitch to handle standard or enhanced printing of up to 48 characters per line on 39- to 59-line tickets. Stepper motor advance for 6 lines to the inch or .110" for graphics.

Mountable on tabletop or wall, the DMTP-9 does it all with advanced stepper motor control electronics and a long-life needle matrix print head. For still more versatility, get it with the optional controllers, power supplies and interconnect cables systems for complete microprocessor/microcomputer compatibility, too. But first, write or call to get more details. Ask for Bulletin 924.

PA
PRACTICAL AUTOMATION, INC.
Trap Falls Road, Shelton, Conn. 06484/Tel: (203) 929-5381

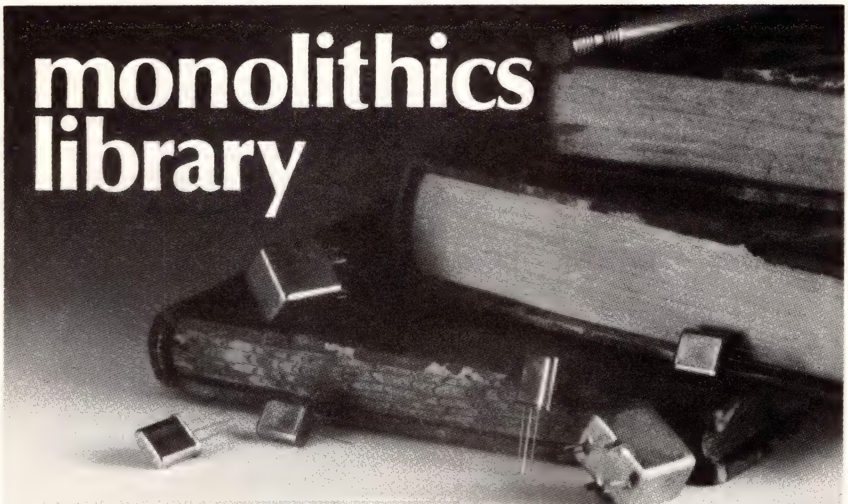
CIRCLE NUMBER 122

This little book can save your company big money.

Rental Electronics, Inc.
(800) 227-8409

In California (213) 993-7368, (415) 968-8845 or (714) 879-0561

CIRCLE NUMBER 123



We wrote the book on eliminating noise and interference and IM! The leading characters are our monolithic crystal filters — over 60 off-the-shelf models at 10.7 and 21.4 MHz — plus supporting characters from 5 to 180 MHz. The plot is simple . . . meet your toughest filter requirements for the lowest possible cost. Write for a review.

The standard in monolithic crystal filters.

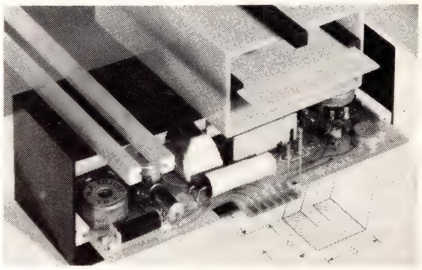
WE WROTE THE BOOK.

Pii

Piezo Technology Inc.
2525 Shader Rd., Orlando, FL 32804
(305) 298-2000

CIRCLE NUMBER 124

Glass epoxy card holders dampen vibration damage



Stevens Tubing, 128 N. Park St., East Orange, NJ 07019. (201) 672-2140. $1.00/ft.

Molded glass-epoxy card holders help dampen damaging board vibration in mobile applications. The holders are lighter than aluminum, yet offer great flex strength. The nonconductive epoxy eliminates electrical short problems encountered with metal holders. The holders measure 1/4 in. square.

CIRCLE NO. 383

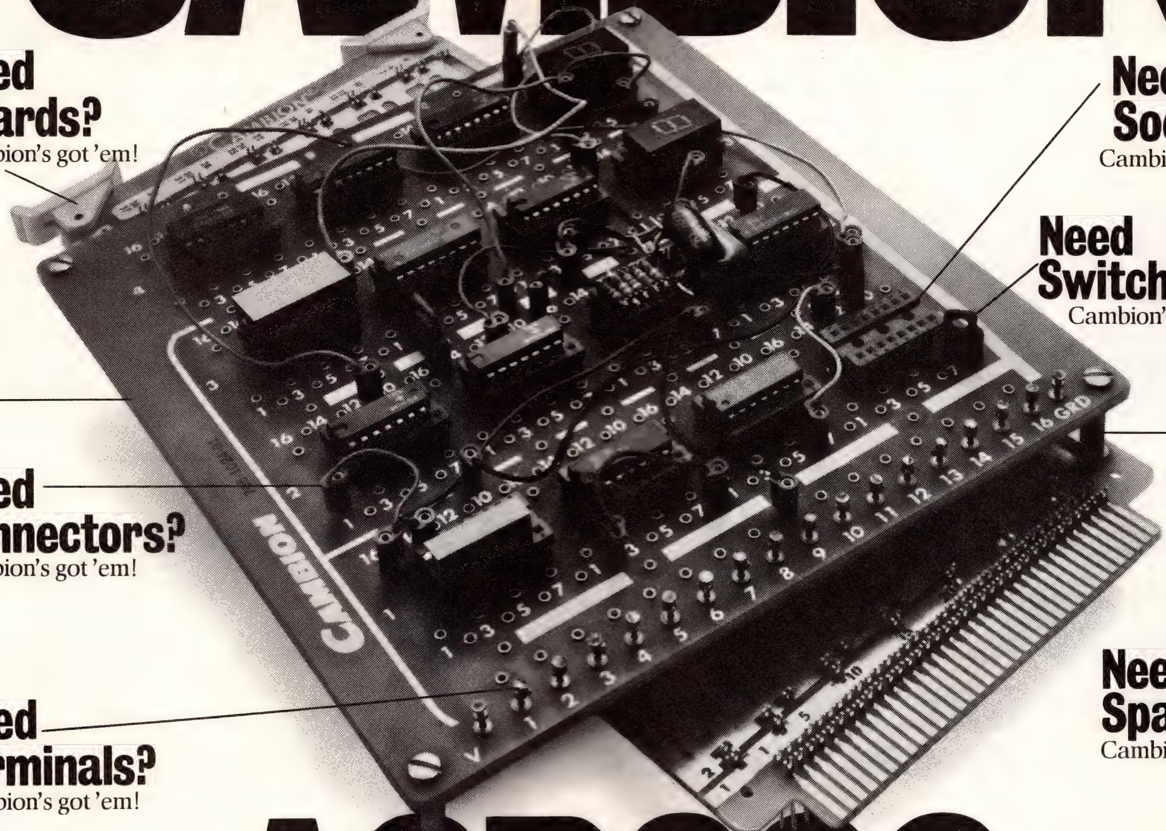
Twinaxial connectors link EDP peripherals

Amphenol, 2122 York Rd., Oak Brook, IL 60521. (312) 986-2700.

Twinax Series connectors facilitate interconnection of mainframe computer systems with CRT displays, high-speed printers and other peripheral equipment. The series includes a plug, which terminates Belden YR15662, Brand Rex T9756A or equivalent twinaxial cable, a receptacle and an adapter for in-line cable splices. A pin-and-slot keyway maintains conductor polarization. Male contacts are silver-plated brass; female contacts, silver-plated beryllium-copper. All other parts are brass with a nontarnish finish. The weatherproof connectors operate through 500 MHz with a nominal impedance of 90 Ω. Peak voltage rating is 500 V. Thermal limits are −55 to 85 C.

CIRCLE NO. 384

CAMBION



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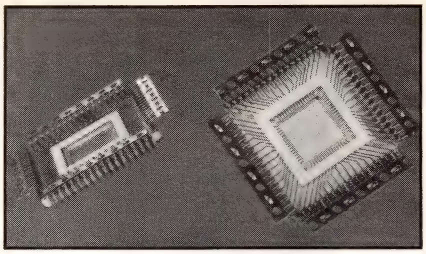
CIRCLE NUMBER 91

Fold-around clips package ceramic chip carriers for easy connections

Berg Electronics Div., Du Pont Co., New Cumberland, PA 17070. James Dilliplane (717) 780-2034. P&A: See text.

Half-hard phospher-bronze contacts, called LSI-Clips, easily fold around ceramic chip carriers to provide rapid, low-cost connection to PC boards and sockets.

Made with tin/lead preplating and having 0.050-in. centers, the LSI-Clips, fit around the contact edges of 0.045-in. or 0.062-in. thick JEDEC ceramic packages. The resulting package can then be surface-mounted on a PC board, soldered onto the board (with LSI-Clip soldertail units), or simply fitted into an appropriate carrier socket.



Automatic equipment, designed to apply the LSI-Clips to ceramic substrates at a rate of 750 chip carriers per hour, will be available in July. In the meantime, the LSI-Clips themselves are available for hand-insertion with bench tooling. Delivery takes four to six weeks.

CIRCLE NO. 324

Equipment handle hides to enhance panel looks

Southco, Brinton Lake Rd., Concordville, PA 19331. (215) 459-4000.

An easy-to-grip handle, No. 67, rotates into a concealed position to enhance the appearance of panels. In its concealed position, all that shows on the panel is an attractive, slim, black escutcheon with an anodized aluminum strip. The pull rotates into its open position by pressing the bottom of the aluminum strip and pulling forward on a small tang at the top. No. 67 concealed pulls come with mounting hardware.

CIRCLE NO. 385

Multi-deck rotary switch ends point-to-point wiring

AMF Electro-Components, 2713 Gateway Dr., Pompano Beach, FL 33060. (305) 973-8620.

A multi-deck, miniature rotary switch, RCL "X" Series, eliminates all point-to-point wiring. The PC-mount switch is totally enclosed. Behind-panel depth is only 0.677 in., with only 0.3 in. additional for each deck up to a total of twelve. Adjustable stops are available. Each deck contains 12 active positions with any combination of shorting and non-shorting actions available on any single deck. Molded-in terminals provide contact stability.

CIRCLE NO. 386

CASSETTE...
MINI-CASSETTE...
CARTRIDGE...

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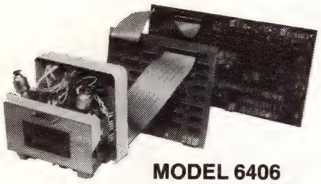
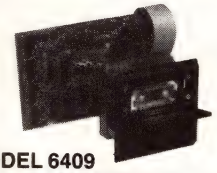
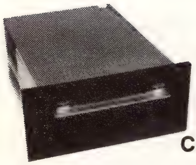


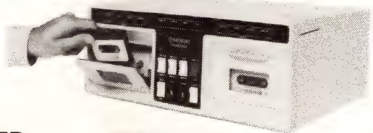
MODEL 6406 RAYCORDER — Popular since 1970, now with all new electronics.



MODEL 6409 MINI-RAYCORDER — A proven performer in a tiny package — many new features.



MODEL 6413 CARTRIDGE RAYCORDER — Fast becoming the standard by which others are judged.



MODEL 6801 RAYCORDER CASSETTE TERMINAL — A stand-alone terminal with a virtually unlimited number of operating modes.

Raycorder Products Division
Raymond Engineering Inc.
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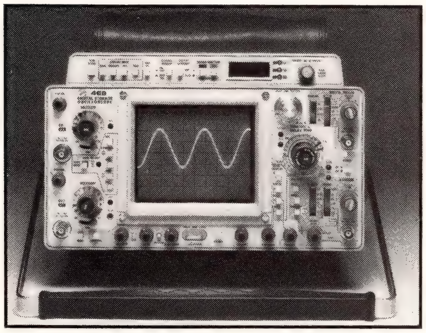
CIRCLE NUMBER 115

Digital storage scope expands bandwidths, reduces display jitter



Tektronix, MS 76-260, P.O. Box 500, Beaverton, OR 97077. (800) 547-1512. $5000; August.

Combining proven performance with new capabilities, Tektronix' 468 digital storage oscilloscope attacks three problems plaguing earlier digital-storage efforts—bandwidth limits, detection of aliased signals and correction of envelope error and display jitter.

All the capabilities of the 465B 100-MHz scope are carried over into the 468. In its storage modes, the new scope acquires and holds waveforms with just the push of a button.

A 25-megasample/s, 8-bit digitizer and a display-interpolation technique achieve a 10-MHz "useful-storage bandwidth." The parameter defines the maximum frequency sine wave, which can be stored in a single sweep with less than 5% envelope error.

Working in an envelope mode using dual sampling rates, the 468 records maximum and minimum values of an envelope over a selectable number of sweeps. This mode captures narrow pulses on long sweeps and is useful in catching gliches, viewing waveform excursions and detecting aliasing.

Jitter-correction circuitry corrects for the ±1/2-sample interval shifting of a waveform caused by the asynchronous relationship between the trigger point and the sample clock.

CIRCLE NO. 326

Video pattern generator slips into your pocket

Hickok Electrical Instrument, 10514 Dupont Ave., Cleveland, OH 44108. (216) 541-8060. $159.

A compact video pattern generator, Model 240, assists the adjustment of industrial video monitors and recorders. The pocket-sized unit generates eleven video or rf patterns, including a ten-step gray-scale staircase and a 10-bar gated rainbow. Crystal-controlled chroma and timing oscillators are used for stability from −20 to 125 F. A tough thermoplastic case protects the instrument under demanding and abusive conditions. Power is supplied by an ac adaptor supplied with the unit or by two, internal 9-V batteries.

CIRCLE NO. 387

THE CASE FOR CAMBION CAGE JACKS!

As a component-mounting connector, our miniature closed-entry *Cage Jack* provides the circuit design engineer with unprecedented flexibility. Cambion originated the cage jack over a decade ago but a lot of people still don't know about its many applications. Our case is made in a useful catalog. Get it and cage jack evaluation samples from Your Cambion Connection at over 100 distributor locations! Cambridge Thermionic Corporation,
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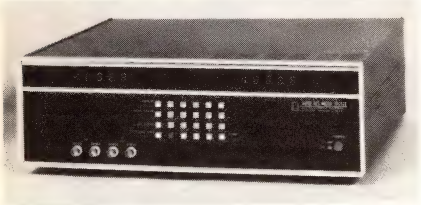
The Right Connection.

CIRCLE NUMBER 92

Dc resistance meter works in high-volume testing

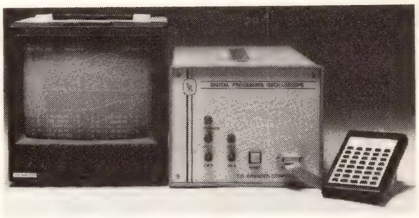


Electro Scientific Industries, 13900 N.W. Science Park Dr., Portland, OR 97229. (503) 641-4141. $3295.

A microprocessor-controlled automatic resistance meter, Model SP2522, operates at speeds under 100 ms for use in high-volume testing. An optional handler interface kit adapts the unit to high-speed parts handlers. Resolution is 100 μΩ to 20 MΩ with 0.02% typical accuracy through 2 MΩ and 0.2% accuracy at higher resolutions. Features include ten programmable sorting limits (in units or percent reading), programmable settling time, autoranging and remote programming capability.

CIRCLE NO. 388

Digital processor displays analog waveforms



T.G. Branden, 5565 S.E. Industrial Way, Portland, OR 97222. (503) 659-9366. From $5495; 4 wks.

A digital processing oscilloscope, Smartscope, combines hardware and software routines to aid analog waveform analysis. Built around a 16-bit microprocessor, the instrument acquires, processes and displays analog information on a CRT or supplies results for storage on disk, plotting or transmission to a computer. All functions are programmable and controlled by a user keypad. Features include dual cursors with digital readout of amplitude and time, array and register operators, fully annotated displays representing actual user parameters, variable length memory with up to 10,000 data points for a single channel, eight arrays for display and storage and a variable sampling rate from 1500 s per sample to 15 μs per sample.

CIRCLE NO. 389

Digital radiometer spots UV from 320 to 380 nm

Spectronics, 956 Brush Hollow Rd., Westbury, NY 11590. (516) 333-4840.

A digital radiometer, DM-365N, measures ultraviolet radiation in the spectral range of 320 to 380 nm. Overall accuracy is ±5%. Three sensitivity ranges cover from 0 to 20,000 μW/cm². Linearity is ±1% over the total range. High-quality interference filters control spectral coverage, eliminating meter sensitivity to infrared and other unwanted radiations. The meter is approved for Specification MIL-I-6868E.

CIRCLE NUMBER 390

FREEDOM OF CHOICE FROM TECNETICS

Until now, the field has been pretty limited in low power, high reliability 400Hz to DC single phase power supplies. Tecnetics changed all that with the introduction of its new 400 Series.

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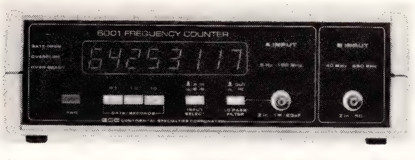
CIRCLE NUMBER 113

Frequency counter operates in a scaling mode



Continental Specialties, 70 Fulton Terrace, New Haven, CT 06509. (800) 243-6077. $385.

Use of an external timebase allows operation of a 650-MHz frequency counter, Model 6001, in a scaling mode. The instrument contains a precision 10-MHz crystal oven oscillator. Use of an external reference, through a rear-panel BNC connection, allows presentation in units other than Hertz. The 6001 can be used as a directly-indicating digital display for transducer translation, flow monitoring, tachometry and more. A 5-Hz to 100-MHz input offers a 1-MΩ, 10-pF input impedance. A switch-selectable low-pass filter in this range provides a 3-dB/octave rolloff at 50 kHz to facilitate audio and ultrasonic measurements. A second input covers 50 to 650 MHz, offering a 50-Ω input impedance and fuse protection. An 8-digit LED display features lead-zero blanking, 0.43-in. characters, a decimal point in the MHz position and a contrast enhancement filter.

CIRCLE NO. 391

Sweep/function generator covers 0.002 to 2 MHz

Leader Instruments, 380 Oser Ave., Hauppauge, NY 11787. (516) 231-6900. $495.

A function/sweep generator, Model LFG-1300S, covers 0.002 to 2 MHz in eight ranges. Linear and logarithmic sweep modes are available with sweep widths up to 1000:1 and sweep rates of 0.5 to 50 Hz. The generator's output frequency can be varied by an external 0 to 10-V signal. Waveform outputs include sine, triangle, sawtooth and pulses. Symmetry of the pulse output is variable from 9:1 to 1:9. In pulse mode, adjustments of pulse width will not change the pulse repetition rate. Output level is continuously variable from 0 to 20 V pk-pk into a 50-Ω load. A pushbutton attenuator provides up to 70-dB attenuation in 10-dB steps. An auxiliary connector provides TTL-level signals to drive logic circuits.

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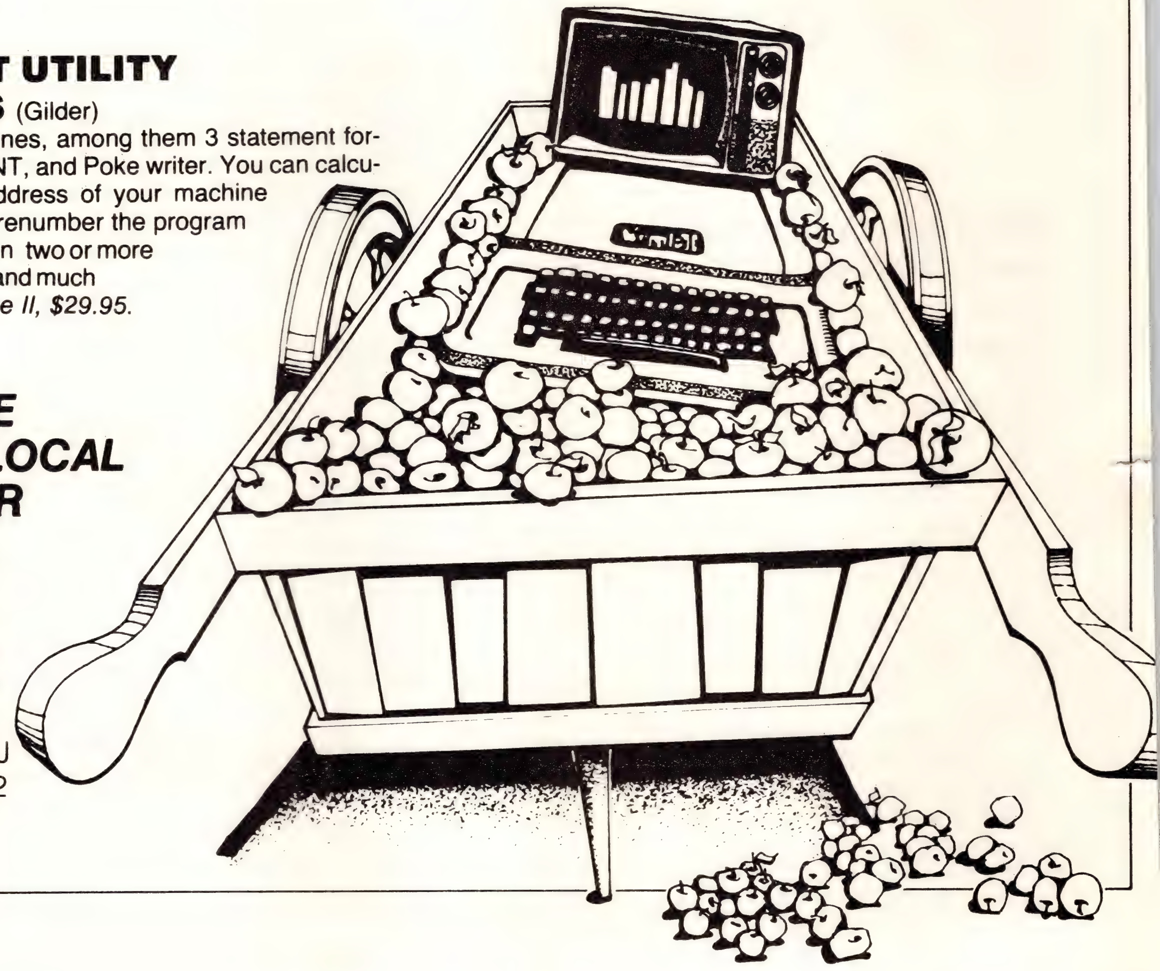

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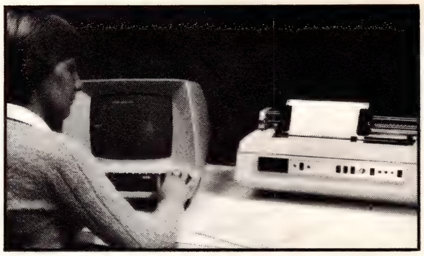
μC system brings together modules covering wide application range

Matrox Electronic Systems, 5800 Andover Ave., Montreal, Quebec H4T 1H4, Canada. $5990; 4 to 6 wks.

A modular, Multibus-compatible microcomputer system with CP/M2.0 disk operating software, the MACS-10 by Matrox, brings together many board-level μC parts—some already released, some making their first appearance—to tackle applications ranging from software development to OEM computers. Not only is all the system hardware modular, but the boards are available separately to facilitate software development on hardware destined for a target system.



A single-board ZBC-80 computer takes advantage of a variety of high-level languages, including Pascal, Cobol, Basic and Fortran. An FFD-1 floppy-disk controller/RAM card, containing 32 kbytes of on-board, dual-ported RAM, uses an FD-1795 formatter/controller chip to direct the operation of up to four single-sided or double-sided drives.

A DF-28 dual 8-in., double-density, floppy-disk drive and CCB-7 seven-slot card-cage/backplane conform to EIA 19-in.-rack spacing. The ZBC-80 and FFD-1 cards occupy two slots in the DDB-7, leaving five slots for system expansion. If more slots are needed, up to three card cages can be stacked together for a maximum of 19 free card slots. The card-cage/backplane includes a power supply and fan.

The MACS-10 is built around a 4-MHz 280A CPU, 48 kbytes of RAM and sockets for 8 kbytes of ROM/EPROM. Support hardware for the system includes a 128-kbyte RAM card and a wide selection of alphanumeric and graphic video-display controllers.

CIRCLE NO. 327

One-board μC develops and evaluates Z8-based system

Zilog, 10460 Bubb Rd., Cupertino, CA 95014. (408) 446-4666. $1700.

A single-board microcomputer system, the Z8 Development Module, assists in development and evaluation of hardware and software for systems based on the Z8 single-chip microcomputer. The module uses a 64-pin version of the Z8 to prototype a Z8-based system. The code thus developed can be transferred to the ROM on a mask-programmed version of the Z8. Two Z8s are included on the module: a program monitor CPU and a user-accessible CPU that can also address external memory. Two serial RS-232C interfaces allow stand-alone use with a CRT or connection to the PDS or ZDS-1 series development systems. The module contains 4 kbytes of monitor EPROM and 2 kbytes of static RAM. A socket allows addition of 2 kbytes of EPROM in place of the RAM.

CIRCLE NO. 393

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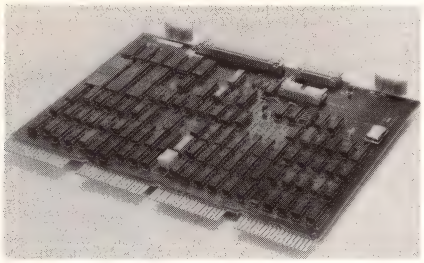
CIRCLE NUMBER 118

Controller interfaces hard disks to LSI-11



Distributed Logic, 12800-G Garden Grove Blvd., Garden Grove, CA 92643. (714) 534-8950. $1592 (50 qty); stock to 4 wks.

A quad-size disk controller, Model DQ-201, interfaces DEC's LSI-11, 11/2 and 11/23 computers with Shugart's SA 4004 or SA4008 hard-disk drives. The board is plug-in ready for the LSI-11 sub-Unibus and connects directly to the drives without external support electronics. A full-sector buffer is included to eliminate data late errors due to DMA latency. Features include automatic media flow compensation with bad sector flagging and transparent automatic track skipping. An on-board bootstrap loader with 128 bytes of spare data area aids special applications. Extended memory addressing capability is offered to 128 kwords. Self-test mode is automatic.

CIRCLE NO. 394

Single board solves math for Multibus systems

Advanced Micro Devices, 901 Thompson Pl., Sunnyvale, CA 94086. (408) 732-2400. $595; stock.

An arithmetic floating-point processor board, Am95/6012, enhances the operation of Multibus systems. The board performs add, subtract, multiply and divide operations in either 32-bit single-precision or 64-bit double-precision formats. Data format of the result conforms to the proposed IEEE floating-point format. In a system, the Am95/6012 occupies four consecutive I/O ports. The CPU addresses the appropriate port over the Multibus, sends operand and command information over the same bus and continues with other operation. The processor starts automatically upon receipt of a command. Heart of the board is the stack-oriented Am9512 single-chip arithmetic processor. Its speed ranges from 29 μs for a single-precision 32-bit add to 2280 μs for a 64-bit double-precision divide.

CIRCLE NO. 395

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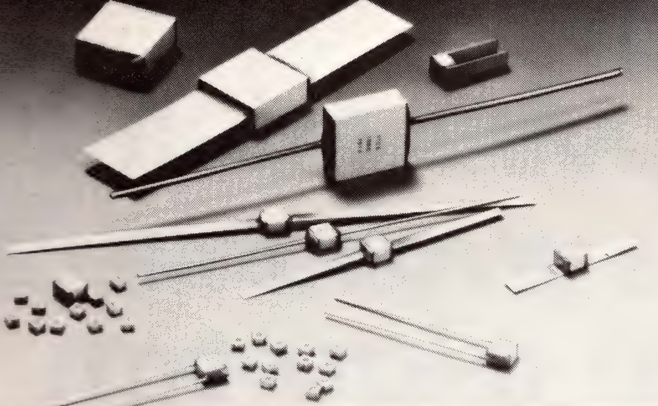

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One Norden Lane, Huntington Station, N.Y. 11746.

CIRCLE NUMBER 128

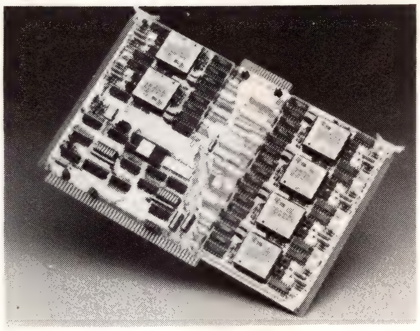
Multi-processor boosts PDP-11 computing power

OVAAC8 International, 4800 Dufferin St., Downsview, ONT M3H 5S9. (416) 661-5088.

A programmable multi-processor, MP-8, enhances the computational power of a DEC PDP-11 minicomputer. The unit can be tailored to meet a wide variety of processing needs which require complex control, I/O and decision functions. The MP-8 contains up to eight processing modules communicating on a common internal bus. Each processor executes programmed functions, callable and, in some cases loadable from a host computer using such high-level languages as Fortran. A dedicated module interfaces the unit to the host computer and can support up to six I/O channels. Modules currently available include a general-purpose processor capable of performing multiple or single 32-bit word or four parallel 8-bit operations.

CIRCLE NO. 396

Bubble memory board tips scales at 768-k

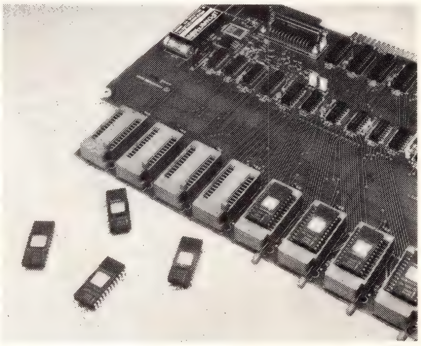


Texas Instruments, M/S 308, P.O. Box 225012, Dallas, TX 75265. (214) 238-2011. $3200 to $15,200; 8 to 10 wks.

The latest addition to the TM990 family of memory boards is the TM990/211, with up to 768 kbytes of nonvolatile storage. The board uses the TIB1000 million-bit bubble memory device. An on-board controller, TIB0903, provides complete interface to the TM990 bus. Data transfers are via the CRU mode. The module can do single or multipage transfers at a maximum data transfer rate of 85 kbits/s. Average access time is 11.2 ms. The module is offered with 1, 2, 4 or 6-Mbit devices to provide from 128-kbytes to 768-kbytes of storage.

CIRCLE NO. 397

Programmer operates in Multibus chassis



Zendex, 6398 Dougherty Rd., Dublin, CA 94566. (415) 829-1284. $450; 2 to 4 wks.

An EPROM programmer, Model ZX-908, operates within a Multibus chassis with simple software drivers. The board is available in models for 2716, 2732 or 2732A devices and has the capacity to program 16 kbytes in one operation. Eight zero insertion-force (ZIF) sockets are provided for quick and safe PROM insertion and withdrawal. The unit requires a 5-V supply. An optional cabinet, with power supply and cables, allows the ZX-908 to operate as a stand-alone unit.

CIRCLE NO. 398

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Daedalon, 35 Congress St., Salem, MA 01970. (617) 744-5310. $495.

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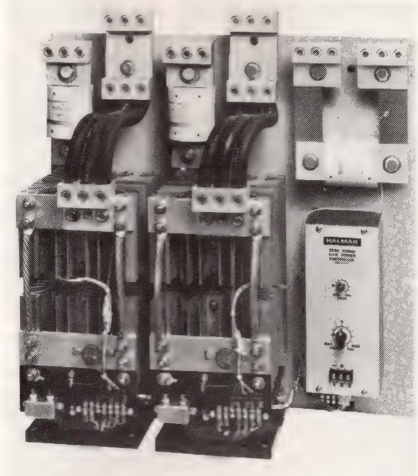
CIRCLE NO. 399

SCR power controllers handle up to 1000 A



Halmar Electronics, 900 N. Hague Ave., Columbus, OH 43204. (614) 275-0530.

Two SCR power controllers, LZF2-800 and LZF2-1000, control up to 800 and 1000 A respectively. The air-cooled units are designed for three-phase power control of resistive loads in standard voltages from 208 to 600 V ac. The units are zero-fired for low noise and rfi-free operation. Power, from 0 to 100% of the output voltage, can be manually or automatically controlled. The controllers measure 24 × 24 × 11.5 in.

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Calma, 527 Lakeside Dr., Sunnyvale, CA 94086. (408) 245-7522.

A high-resolution video display, RB1000, refreshes at a 60-Hz rate to eliminate flicker. The high refresh rate is made possible by an internal graphics processor with its own raster memory. The 1280 × 1024 video monitor eliminates the "stair-stepping" appearance of nonorthogonal lines. The black-and-white screen provides good contrast and clarity for graphics and text. Selective erase increases productivity by reducing screen repainting. Multiport views allows a user to work in any single view without affecting the other views.

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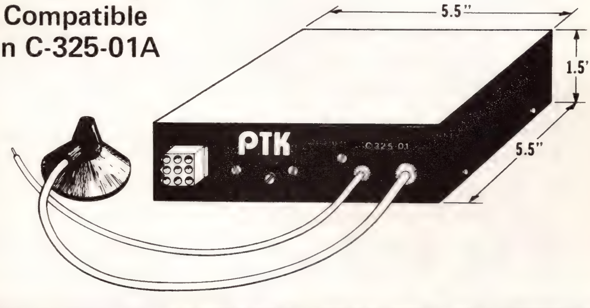

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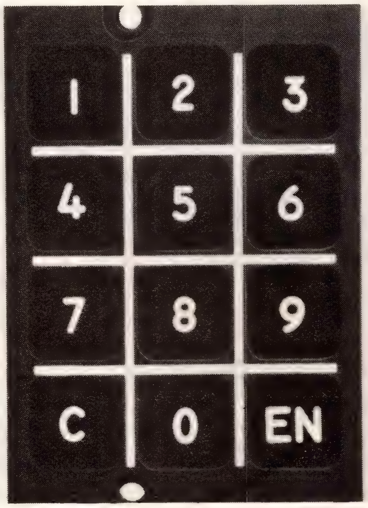
CIRCLE NUMBER 133

Keyboard performs to military requirements



Interface Products, 2185 S. Grand Ave., Santa Ana, CA 92705. (714) 549-4977.

A 12-key keyboard meets military requirements for illumination, as well as the demands of MIL-STD-202 for dielectric, salt spray, insulation resistance, humidity, shock, vibration and thermal shock. A standard model has 0.375-in. square keys although other versions are offered with 10 or 16-key configurations and 0.5 in. square or 0.5 × 0.37 in. rectangular keys. Switch pressures range from 10 to 25 oz and afford positive tactile feedback. Switch travel is typically 0.03 in. The switch's PC board uses 2-oz copper with gold-over-nickel plating.

CIRCLE NO. 454

CRT monitor mounts in page or TV configuration

Video Monitors, 2533 A2 Bernice Rd., Lansing, IL 60438. (312) 895-3012. 4 wks.

A high-resolution, raster-scan CRT module, Model M15P1024H, mounts on a chassis in a page or TV configuration. Definition is 1024 visible lines in 1/60 s for noninterlaced operation or 2048 lines in 1/30 s for interlace operation. Scan frequency is approximately 64 kHz. Separate synchronizing TTL inputs are accepted. Video bit streams to 80 Mbits/s are handled by a wide bandwidth video amplifier. The monitors are supplied with white P4 or PC104 phosphors, but can be supplied with any standard EIA-registered phosphor.

CIRCLE NO. 455

High-level language runs on SBC-80 one-board μCs

Zendex, 6398 Dougherty Rd., Dublin, CA 94566. (415) 829-1284. $450.

A high-level programming language, SBC-Forth, runs on Intel's SBC-80 series of single-board computers and National's equivalent series of BLC-80 products. A resident assembler, compiler and editor can eliminate need for costly microcomputer development systems. Their interactive nature allows SBC-Forth to be coded and tested in small, easy-to-handle portions—all in a single session. The software is capable of symbolic debugging since routines are invoked by their actual name. Each routine definition name is fully entered in a variable dictionary.

CIRCLE NO. 456

Real-time executive offers improved speed

Process Computer Systems, 750 N. Maple Rd., Saline, MI 48176. (313) 429-4971.

A real-time executive package, RTX, offers an alternative to the recently released Industrial Pascal. RTX is more compact than the Pascal package, requiring less than 2.1 kbytes of ROM. In addition, RTX operates in from 600 to 800 μs per event, compared to 3 to 5 ms for Industrial Pascal. Industrial Pascal is best suited for target environments where the average event occurance time is slower than 10 ms or a rate of less than 100 events/s. At more than 200 events/s, RTX excels.

CIRCLE NO. 457

Software package adds strength to Fortran IV

Software '70, P.O. Box 3623, Anaheim, CA 92803. (714) 992-2230. $295.

Fort/Lift, a software package for most minicomputers, microprocessors and mainframes, extends the capabilities of Fortran IV. The package contains 24 Fortran-callable subroutines to provide a full complement of character string and substring processing functions, ordered table manipulation function, disk file sort with multiple sort keys and in-memory sort. In addition, the package creates and maintains file which are accessed randomly by free-format record keys.

CIRCLE NO. 458

Cross software develops code for Z8000 μP

Zilog, 10460 Bubb Rd., Cupertino, CA 95014. (408) 446-4666. $10,000.

The Z8000 Cross-Software Package allows users of PDP-11 minicomputers to develop code for the 16-bit Z8000 microprocessor. The package includes a compiler for the C programming language, a code optimizer for the C compiler, a Z8000 assembler, a linker and an upload/download program compatible with the Z8000 development module. The package runs on Western Electric's seventh edition of Bell Laboratories' UNIX time-sharing system. The software package enables users of PDP-11 systems to take advantage of the tools of a larger computer system to develop Z8000 software.

CIRCLE NO. 459

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CIRCLE NUMBER 134

10

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Materials

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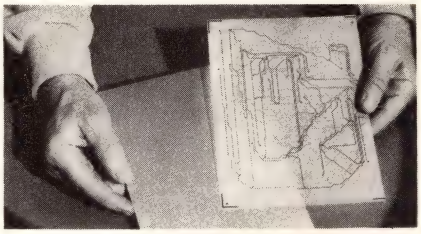

Westinghouse Electric, Micarta Div., Hampton, SC 29924. (803) 943-2311.

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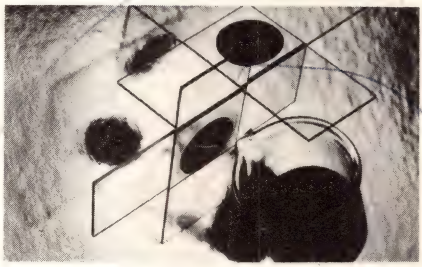
CIRCLE NO. 406

Opaque epoxy shields light-sensitive components

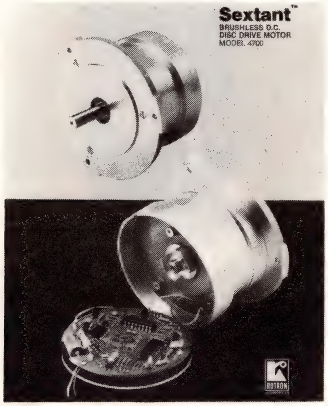


Epoxy Technology, 14 Fortune Dr., Billerica, MA 01821. (617) 667-3805. $18 (8-oz kit).

A black, two-part epoxy compound for coating or potting, Epo-Tek 320, protects light-sensitive components. The opaque material adheres to glass, ceramics, quartz, metals and most plastics. A 0.0005-in. thick film of Epo-Tek 320 transmits less than 0.0001% of light over a range of 3000 Å to one micron. Pot life is at least 1 to 1-1/2 h; shelf life, one year at room temperature. Viscosity at 25 C is 3260 cp; lap shear strength, 1500 lb/in.². Epo-Tek 320 is available in 8-oz evaluation kits.

CIRCLE NO. 407

New Literature



Dc drive spindles

Detailed design and performance data on the Sextant Model 4700 brushless dc drive spindle for computer memory disks is contained in a data sheet. Rotron, Woodstock, NY

CIRCLE NO. 408

Two-component epoxies

Product description, advantages, mix ratios, cure times, viscosities and pot lifes for two-component epoxies are detailed in a brochure. Typical uses are listed. Amicon, Lexington, MA

CIRCLE NO. 409

Isolation amplifiers

Detailed specifications of isolation amplifiers are given in a 16-page catalog. Application notes, technical selection guides and a glossary of terms are included. Intronics, Newton, MA

CIRCLE NO. 410

HV power supplies

Solid-state, regulated and unregulated, rack-mounted, miniature, modular and series regulated high-voltage power supplies are described in a 12-page catalog. Photos and specifications are included for over 1300 models. Spellman High Voltage Electronics, Plainview, NY

CIRCLE NO. 411

Test instruments

A 36-page catalog, *Instruments for Testing and Design*, describes solderless breadboards, instrument cases, logic probes, frequency counters and test other instruments. Continental Specialties, New Haven, CT

CIRCLE NO. 412

Precision thermistors

Specifications, tolerance and temperature-resistance data and applications of thermistors are given in a 20-page booklet. Yellow Springs Instrument, Yellow Springs, OH

CIRCLE NO. 413

Miniature lamps

Miniature precision lamp specifications, such as lumen output, color temperature, filament dimensions, lamp life and electrical characteristics, are given in a 16-page catalog. Gilway Technical Lamp, Woburn, MA

CIRCLE NO. 414

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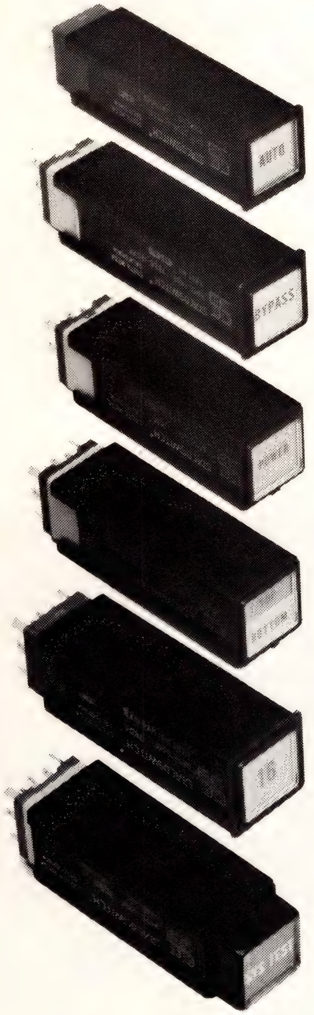

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CIRCLE NUMBER 99

10

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ISSUE

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(continued from page 265)

Bellows

A 12-page catalog includes formulas and a table of convolution properties for bellows. Design factors and typical parts are depicted for electroforms. Servometer, Cedar Grove, NJ

CIRCLE NO. 415

Dc power supplies

Switching and linear, single and multiple-output dc power supplies are described in an eight-page catalog. The catalog contains input and output ratings, power ranges and mounting dimensions for the 9E and 9N Super-Switcher, SM submodular, OEM linear and other specialized lines. Powertec, Chatsworth, CA

CIRCLE NO. 416

I/O systems

A new generation of I/O systems, for local job site monitoring and control and for remote job sites, is described in a 14-page catalog. Opto 22, Huntington Beach, CA

CIRCLE NO. 417

Filters, capacitors

More than 1000 RFI/EMC filters and feedthrough capacitors are described in a 44-page booklet. Mechanical and electrical specifications for filters, rated from 0.5 to 400 A, are provided. RFI, Bay Shore, NY

CIRCLE NO. 418

Switches

A 174-page catalog contains a comprehensive listing of switches, pilot lights and control devices. Relay Specialties, Fair Lawn, NJ

CIRCLE NO. 419

μP-based annunciator

The operation and features of a μP-based annunciator are described in a 22-page brochure. Specifications, options and ordering information are included. Rochester Instrument Systems, Rochester, NY

CIRCLE NO. 420

Coaxial transmission line

A 24-page catalog describes the standard lengths in which rigid coaxial transmission line are available, along with information on end-fitting configurations, components, hardware and installation accessories. FM broadcast antennas are also described, along with performance characteristics. Phelps Dodge Communications, Marlboro, NJ

CIRCLE NO. 421

Power converters

Specifications and price information on more than 1000 power converters are given in a 32-page catalog. Tecnetics, Boulder, CO

CIRCLE NO. 422

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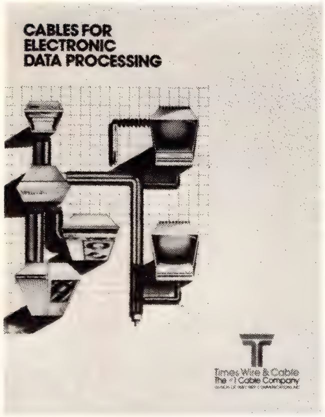
CIRCLE NUMBER 108

(continued from page 267)



CABLES FOR
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EDP cables

Cables for electronic data processing systems are covered in a 23-page catalog. Application notes are provided. Times Wire and Cable, Wallingford, CT

CIRCLE NO. 423

Packaging systems

A 145-page catalog contains information on microelectronic packaging systems and hardware. Mupac Corp., Brockton, MA

CIRCLE NO. 424

LED lamps

A 15-page catalog features LED lamps and display devices. TEC, Tucson, AZ

CIRCLE NO. 425

Flat cable

A 40-page catalog describes flat cable assemblies, connectorized flexible circuits, transmission-line assemblies and PC boards. T&B Ansley, Los Angeles, CA

CIRCLE NO. 426

Electronic packaging

A 60-page handbook describes packaging products, including IC sockets, I/O and PC-board connectors, flat-cable interconnection systems and connectors. Each product section features diagrams, photos, mechanical/environmental/electrical specifications, truth tables and dimensional data. Stanford Applied Engineering, Santa Clara, CA

CIRCLE NO. 427

Machinable glass ceramic

Machinable glass ceramics are described in an eight-page booklet. Graphs provide details of the material's performance in terms of strength, temperature, permeation, outgassing and electrical properties. Corning Glass Works, Corning, NY

CIRCLE NO. 428

Relays

Nearly 1350 stock relays and accessories are listed in a 44-page catalog. Also included are voltage sensors, special-purpose relays and a wide choice of relay sockets, both chassis and PC-board mount. Potter & Brumfield, Princeton, IN

CIRCLE NO. 429

Strip sockets

Strip and pin-line DIP sockets for mounting liquid-crystal displays, other high pin-count or odd-centered components are described in a data sheet. Aries Electronics, Frenchtown, NJ

CIRCLE NO. 430

Control knobs

Specifications for more than 500 types of control knobs are given in a 16-page catalog. Items listed include round, pointer, bar pointer, concentric, tactile and crank knobs, as well as knob and shaft locks and self-locking devices. Raytheon, Burlington, MA

CIRCLE NO. 431

GaAs FETs

Three data sheets present electrical specifications, typical performance curves and outline drawings of GaAs FET amplifiers. The first data sheet covers units in the 2 to 4-GHz frequency range; the second describes units in the 4 to 8-GHz range; the third details units available for 8 to 12.4 GHz. Aertech Industries, Sunnyvale, CA

CIRCLE NO. 432

Electronic test accessories

A 100-page catalog describes electronic test accessories. Conversion tables of temperatures, metric conversion chart, BNC and triaxial cable procedures and a cross-index of connector MIL numbers are provided. ITT Pomona Electronics, Pomona, CA

CIRCLE NO. 433

Memory systems

The architecture and operation of Series 90 general-purpose memory systems are described in a six-page catalog. Intel, Santa Clara, CA

CIRCLE NO. 434

Portable oscilloscope

Specifications of the OS3600, a dual-trace oscilloscope designed for lab or field measurements on both advanced digital and conventional electronic circuits, are given in a two-page catalog. Gould, Instruments Div., Cleveland, OH

CIRCLE NO. 435

Software

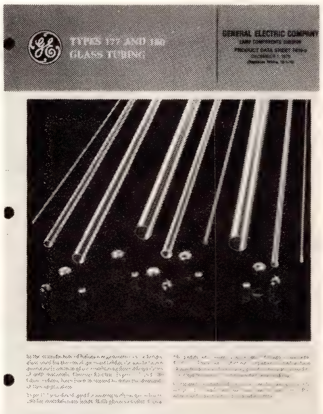
A 20-page applications software brochure is illustrated with photos, charts and line drawings. CRT screen illustrations aid the user in following the system descriptions. Educational Data Systems, Irvine, CA

CIRCLE NO. 436

Analog test systems

An 18-page brochure focuses on the A310 Series of analog LSI test systems designed for testing codecs, precision converters and other complex components containing analog and digital circuitry. Teradyne, Boston, MA

CIRCLE NO. 437



TYPES 177 AND 180
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Glass tubing

Data on two types of glass tubing for the manufacture of halogen regenerative cycle lamps are given in a four-page catalog. A complete list of available sizes and wall thicknesses is provided. General Electric, Lamp Components Sale Operation, Cleveland, OH

CIRCLE NO. 438

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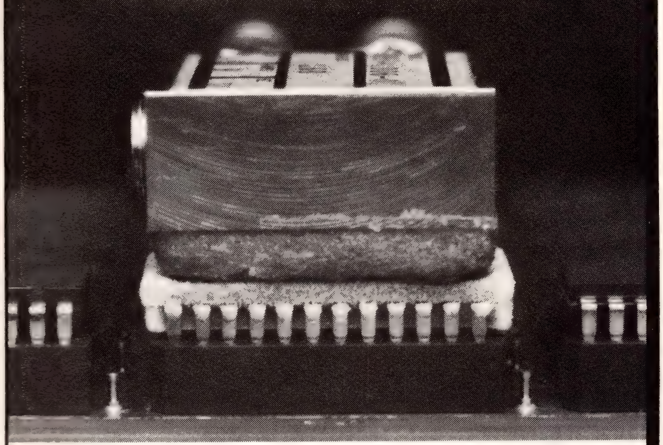

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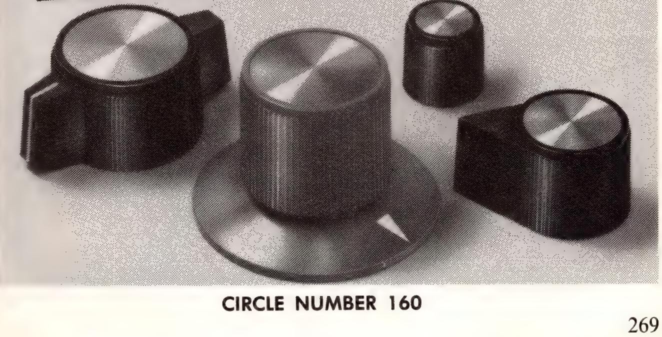

CIRCLE NUMBER 160

Application Notes

Cables

How to quickly and accurately select the exact microcomputer and peripheral interface cable needed for your requirements is shown in a catalog. Inmac, Santa Clara, CA

CIRCLE NO. 439

Analyzer/recorder

An eight-page bulletin, fully illustrated with block diagrams, graphs, instrument printouts and information in tabular form, focuses on the latest innovation in line disturbance monitoring. The bulletin describes the hardware, interfaces and theory involved in impulse strength measurement and explains the significance of the resulting data. Dranetz Engineering Laboratories, South Plainfield, NJ

CIRCLE NO. 440

Foil capacitors

The Noninductive Myth debunks the popular misconception that extended foil capacitors are noninductive. It also provides formulas and graphs to allow the calculation of the inductance of all common geometries used with capacitors. CSI Capacitors, Encondido, CA

CIRCLE NO. 441

LEDs

Design features of LED matrices, including voltage-current characteristics and luminous intensity, are described in a 28-page catalog. Design problems and multiplexing techniques are discussed. Lamp Div., General Instrument, Chicago, IL

CIRCLE NO. 442

Partials testing technique

An application report describes how J387 and J387A memory test systems can be used to test for partials—dynamic RAMs in which some bits are nonfunctional. The technique allows the use of devices that would otherwise be rejected. Teradyne, Memory Products, Woodland Hills, CA

CIRCLE NO. 443

Thermal printheads

How the printing rate of thick-film thermal printheads can be maximized by using external means to compensate for the inherent physical properties of the printing element is illustrated in a two-page data sheet. Gulton Industries, Hybrid Microcircuit Dept., Metuchen, NJ

CIRCLE NO. 444

Bipolar transistors

A 4.3-GHz Oscillator Using the HXTR-4101 Bipolar Transistor takes a step-by-step approach to creation of an oscillator with maximum output power at a desired frequency. This analytical approach is appropriate for use with GaAs FETs as well as silicon bipolar transistors. Hewlett-Packard, Palo Alto, CA

CIRCLE NO. 445

Thick-film trimming

The objectives and principles behind laser trimming of thick-film resistor networks are covered in a 16-page brochure. Teradyne, Boston, MA

CIRCLE NO. 446

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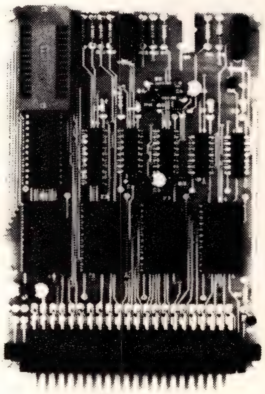

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Electrical steel

How to select the proper shape, grade and gauges of electrical steel for both power and signal transformers is shown in a catalog. Magnetic Metals, Camden, NJ

CIRCLE NO. 447

Solid-state keyboards

An introduction to solid-state capacitive keyboards and application data are provided in a 14-page brochure. Step-by-step instructions and flow charts allow a user to customize the keyboards to meet his needs. Cherry Electrical, Waukegan, IL

CIRCLE NO. 448

Woven wire and cable

Applications of woven wire and cable are explained in a six-page catalog. Woven Electronics, Mauldin, SC

CIRCLE NO. 449

Integrated circuits

Many applications for the company's timer, counter and display driver ICs are detailed in a 30-page handbook. Intersil, Cupertino, CA

CIRCLE NO. 450

Motors

How the innovative application of existing time-tested technology makes it possible to protect motors under overload conditions before they are damaged is discussed in a six-page note. Klockner-Moeller, Natick, MA

CIRCLE NO. 451

Matched thermistors

The use and applications of thermistors in ecology instrumentation are described in a 24-page catalog. Fenwal Electronics, Framingham, MA

CIRCLE NO. 452

Thick-film capacitors

Dielectric and overglaze materials capable of solving problems commonly encountered in thick-film capacitor fabrication are covered in a paper. Electro-Science Laboratories, Pennsauken, NJ

CIRCLE NO. 453

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Engineers testify at energy hearings

Four representatives of the engineering community blamed environmental restrictions and government inertia for contributing to the energy crisis, as the first nongovernment witnesses before the U.S. House of Representatives' Subcommittee on Energy Research and Production, chaired by Congressman Mike McCormack (D-WA). Their testimony, on Feb. 28, advocated ways to assure the U.S. adequate future supplies of energy and nonfuel resources and concluded three days of activities sponsored by this year's Engineers Public Affairs Forum held in Washington DC.

First to testify was Thomas H. Lee, staff executive, power systems technical operations, General Electric (Fairfield, CT). Dr. Lee argues that electricity derived from domestic coal, hydro and nuclear fuel should be substituted for imported oil and gas to produce industrial heat and steam. He suggests that energy independence will require increased utility rates, the construction of more conventional and nuclear-powered generating plants and revised environmental protection rules that allow for growth in generating capacity. Dr. Lee defends his position on the use of electricity as boiler fuel, despite thermodynamic inefficiency, on the grounds that it solves a pressing political problem—though it is not the "ideal" technical solution for the long term.

As the next witness, Lewis Conta, engineer in residence, Engineering Societies Commission on Energy (Washington D.C.) graphically demonstrated petroleum use trends over the past 30 years. His data show oil consumption rising while production levels off and new discoveries dwindle. For the short term, he predicts gasoline rationing is mandatory; the lead-time to do anything with synthetic fuels in the 1980s is already gone.

William H. Dresher, dean of mines at the University of Arizona, used his time before the Subcommittee to enumerate the many nonfuel mineral imports on which the U.S. depends. He criticized government regulations on nonfuel mineral production, including environmental restrictions, health/safety regulations, tax laws and patent policies.

Finally, Edgar Pavia, President, Pavia-Byrne Engineering Corp. (New Orleans, LA) criticized all environmental legislation presently on the books and expressed hostility to advocacy positions that have attempted to delay, if not completely stop, nuclear power plant construction. His testimony, laced with such phrases as "pseudo-environmental groups" and "no-growth crowd," received favorable comments from Chairman McCormack.

New rules announced for IEEE petitioners

Starting with the 1981 election, petition candidates for IEEE president and executive vice president can no longer get on the ballot by petitioning in just a few large regions to demonstrate support from 1% (or more) of the membership. Successful petitioners must now show at least 1% support within a majority of IEEE regions. Similar rules apply for regional director posts. Petitioners here must show support from a majority of sections within a region.

Of the ten IEEE regions, six are within the U.S. Therefore, a domestic presidential candidate could get all the signatures necessary without canvassing foreign IEEE members.

Technical exchanges falter between U.S. and USSR

In at least three separate actions, U.S. engineering groups have suspended or terminated relationships with their peers in the USSR.

On February 25, the IEEE suspended its 20-year tradition of annual technical exchanges with the Popov Society, Russia's leading electrical engineering organization. As an immediate result, the Popov Society will not send a delegation to ELECTRO/80 in Boston (May 13-15), and the IEEE has withdrawn its ten-member delegation to the Popov Society Congress in Moscow (May 27-29). IEEE's Board of Directors cited the "current world condition" as the official reason for the suspensions.

Other U.S. engineering societies are also pulling in their welcome mat. Back in January, as a protest against Soviet actions in Afghanistan, the American Society of Civil Engineers rejected a Soviet offer to exchange engineering delegations in 1980. The ASCE has also stopped sending its publications to the USSR.

Also in February, the Association for Computing Machinery, the American Mathematical Society and the IEEE jointly condemned the arrest and banishment of Russian physicist Andrei Sakharov. Their statement predicted, in part, that the arrest would "worsen the climate of scientific cooperation across national boundaries...."

Engineers strike for pay raise, benefits

The strike—an essential bargaining tool for organized labor—is now being used by aerospace engineers at the Kennedy Space Center in pursuit of cost-of-living allowances, time-and-a-half pay for overtime, shift differentials for regularly scheduled night work, salary increases and other benefits.

On February 13, controversy over these provisions led to a breakdown of contract negotiations between Boeing Services International (BSI) and its engineers, who are members of the Florida Association of Professional Employees (FAPE). According to union organizer and spokesman Jim Van Artsdalen, every organized group employed by BSI gets a cost-of-living allowance—except the engineers.

At last report, 160 of FAPE's 185 members are still on strike and BSI has rejected binding arbitration. In an effort to spur negotiations, a federal mediator is meeting with union representatives and management officials in Titusville, FL. The union has been without a contract since its formation in June 1979.

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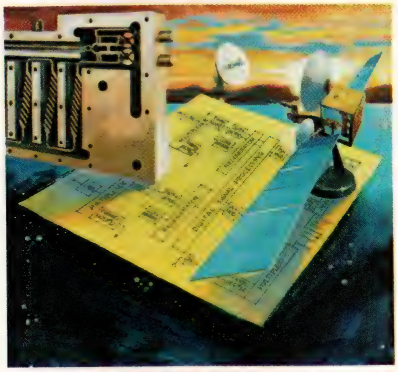

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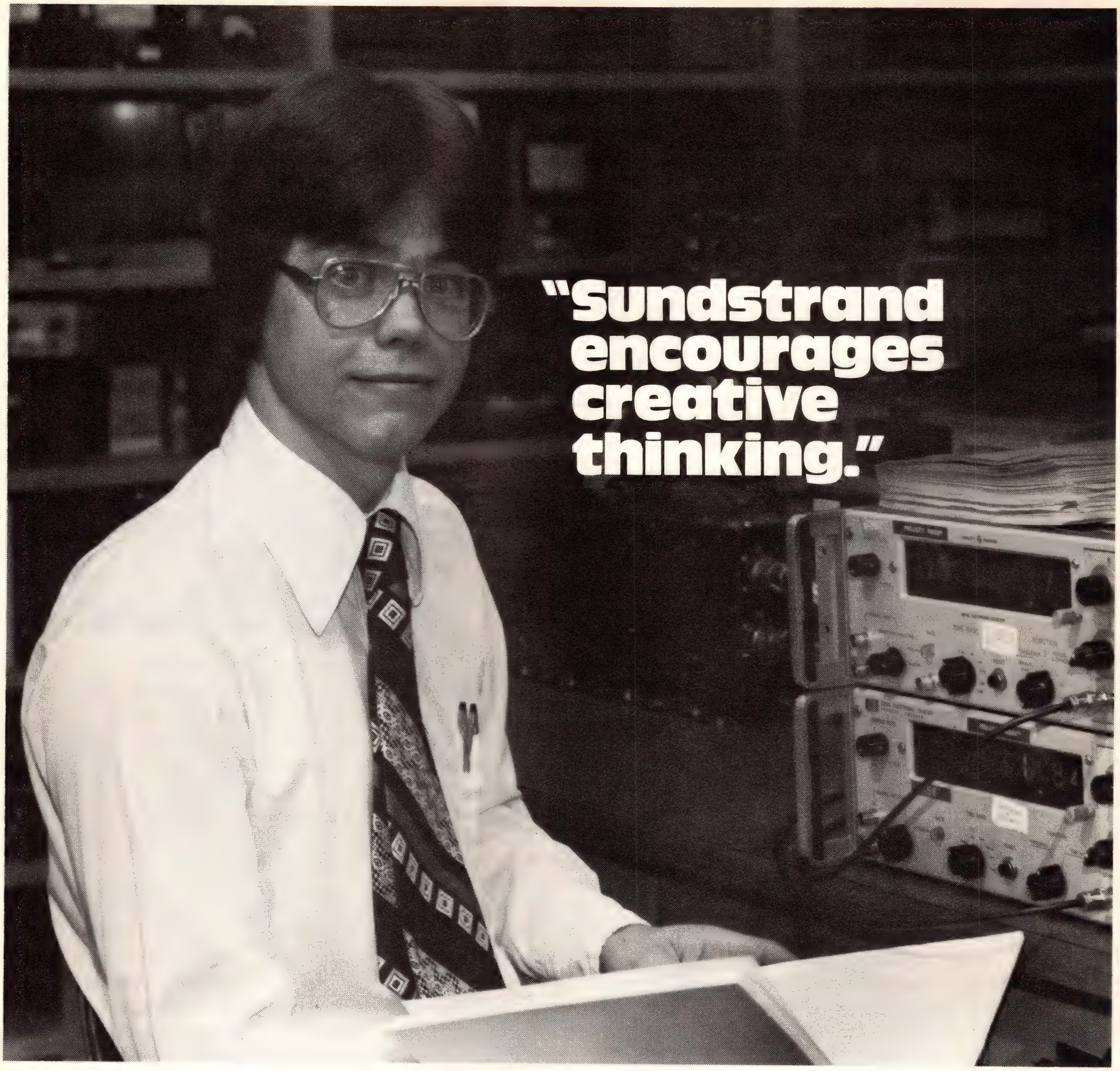
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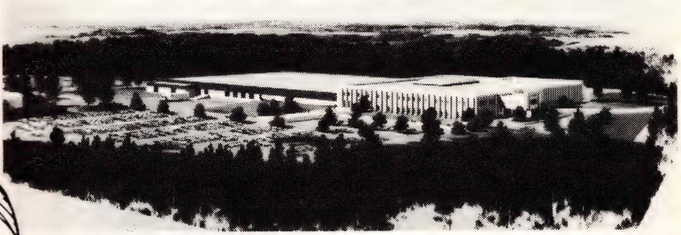

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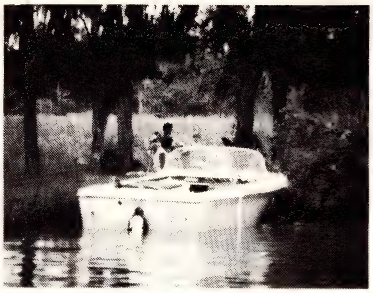

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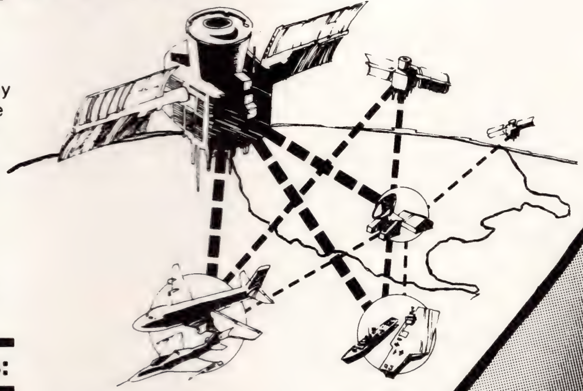

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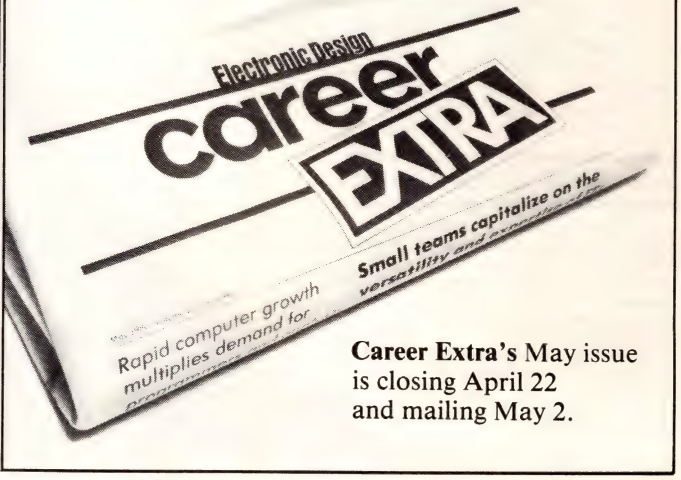
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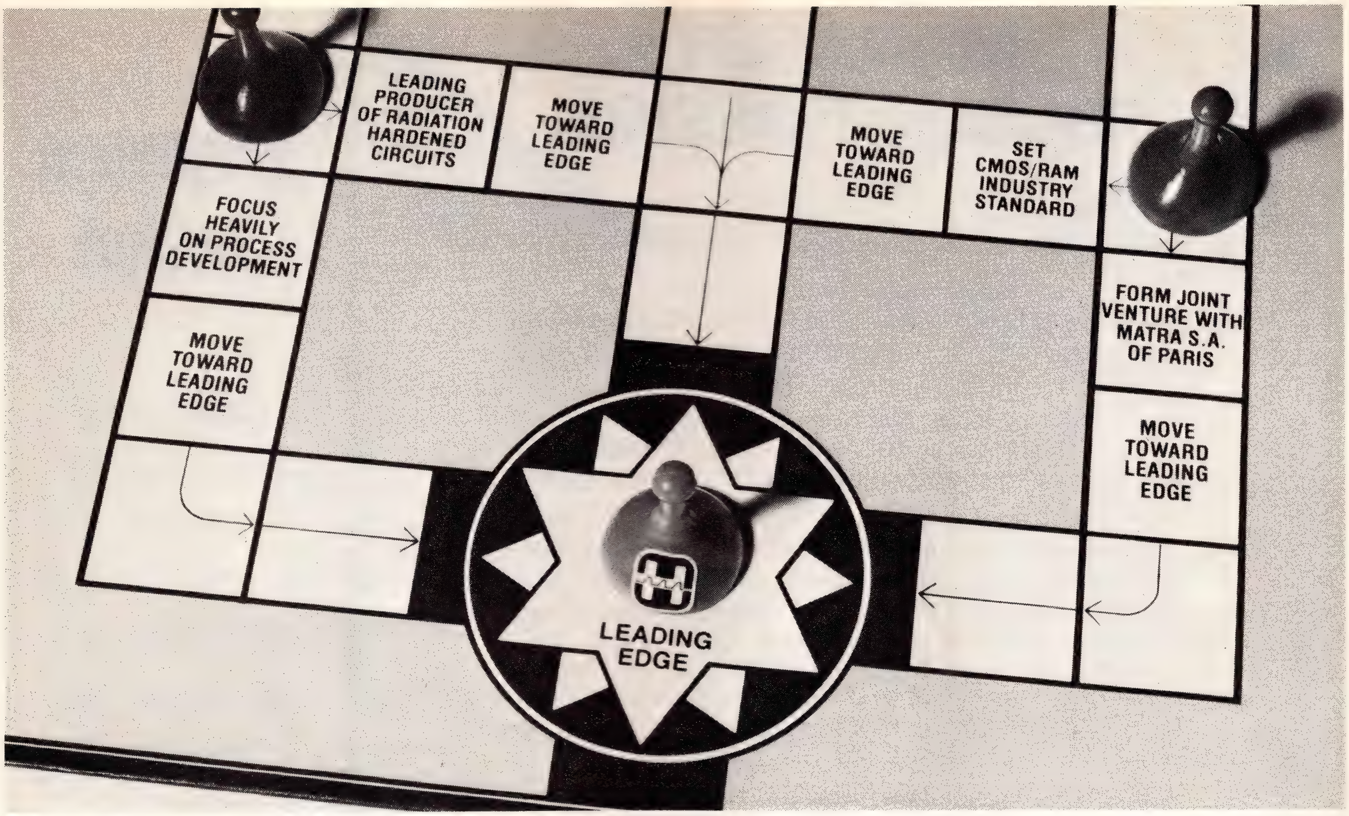
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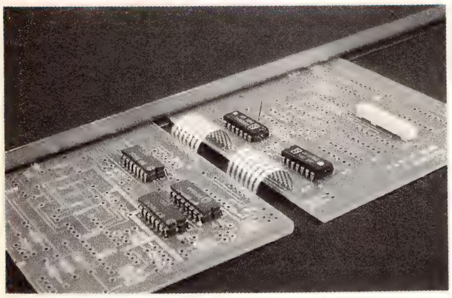
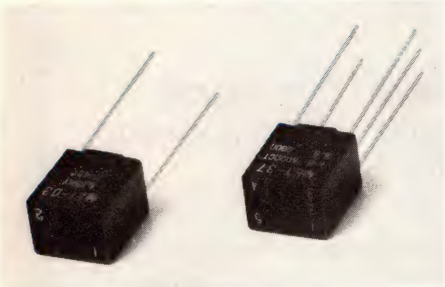


FLEXIBLE HORIZONTAL JUMPERS—Space saving one-piece circuits simplify PCB design, reducing need for expensive multi-layer circuits. Also useful as hinge to join two boards. Rigid integral pins plug directly into board holes or connector sockets. Many standard widths, lengths and conductor centers to meet design needs at minimum cost. Custom configurations also available, including integral pads for solder termination. BMC Box 888, Nashua, NH 03061 (603) 883-5541

ONE-PIECE CIRCUITS **211**



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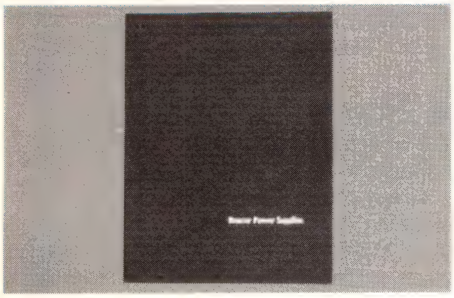
MET/MEI SERIES

212



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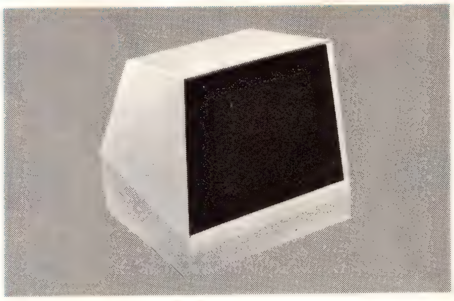
POWER SUPPLIES **213**



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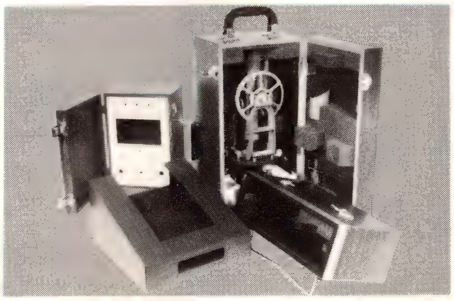
CUSTOM VIDEO DISPLAY TERMINAL **214**



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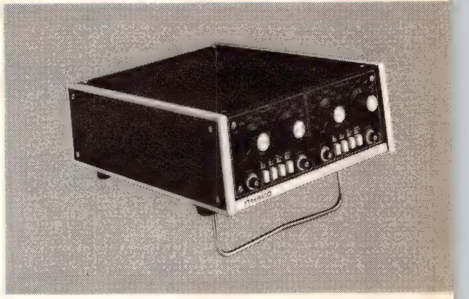

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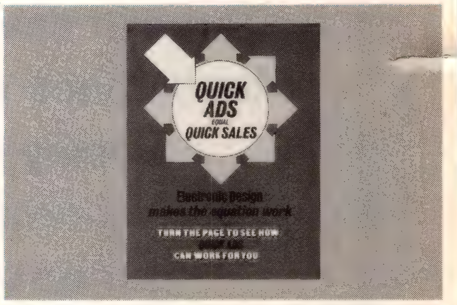
MAGNETIC SHIELDS **218**



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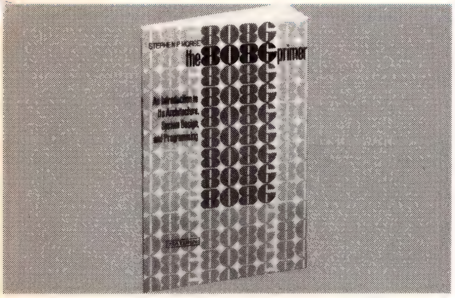
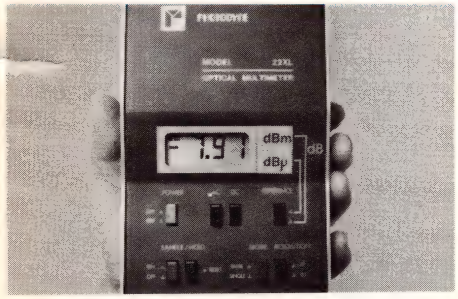
RF TRANSFER SWITCH **220**


STEPHEN P. MORSE
the 8086 primer
An Introduction to its Architecture, System Design and Programming
8086

THE 8086 PRIMER: An Introduction to its Architecture, System Design, and Programming, S. Morse. Written by the man responsible for the architectural definition of the 8086 processor. Describes the 8086 chip in depth, the motivation for the design of the chip, corrected procedures, and internal architecture. #5165-4, 224 pages, $8.95. **CIRCLE THE INFO RETRIEVAL NUMBER TO ORDER 15-day exam copy.** When billed, remit or return book with no obligation. Hayden Book Co., 50 Essex St., Rochelle Park, NJ 07662.

#8086 PRIMER **221**



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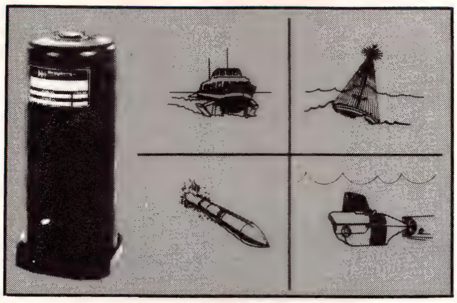
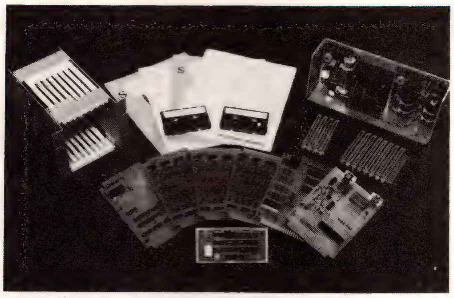
OPTICAL MULTIMETER **222**



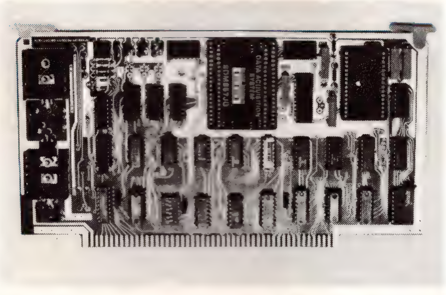
NO-DRIFT NORTH SEEKER MODEL NS13-0101-1 for automatic navigation systems. Provides 360° azimuth through 45° pitch and roll. Uses standard flux gate coil suspended on universal pivot. Continuously registers reference to magnetic North within 2°. Synchro or pot output. Internal DC inverter. Requires 24 to 30V DC. Uses 0.130 amps. Weighs 1.6 pounds. Can eliminate need for more expensive gyros. Humphrey, Inc., 9212 Balboa Ave., San Diego, CA 92123. Phone (714) 565-6631.

NO DRIFT NORTH SEEKER **223**



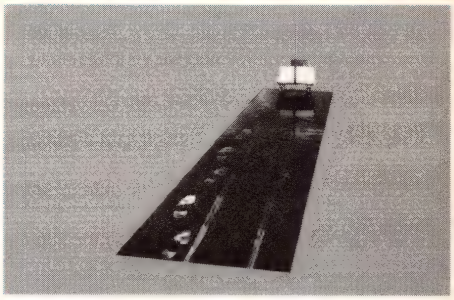
6800 DEVELOPMENT PAC II. Consisting of 6800 CPU, 48K Ram, Erom Programmer, RS-232 interface with switch selectable rates to 9600 baud, cassett interface for 300/2400 baud, *FANTOM-II monitor/debug ROM, editor/assembler, 4K BASIC, card rack, 7 socket back plane, large power supply. All for $1,895. Wintek Corp., 1801 South Street, Lafayette, IN. 47904; 317-742-8428

6800 DEVELOPMENT PAC II **224**



S-100 A/D CONVERTER, 12 BIT The Model AD-100 is a high quality, fast, 12 bit, 16 channel system. Available with programmable gain instrumentation amplifier and sample/hold. Operational Modes: Status Test, CPU Suspension, and 8080/Z80 interrupts. Basic board $575.00 plus options. Delivery - stock to 60 days. California Data Corp. 3475 Old Conejo Road, Suite C-10, Newbury Park, CA 91320 (805) 498-3651

CONVERTERS **225**



PTS CLEAN-ROOM TRAP DUST MAT protects from traffic born contamination. Pulls dust, dirt, even bacteria from shoes, trolley wheels. Used without fixtures at entrances to contamination sensitive areas. Fully washable and re-usable. Genuine Swiss made. Unequaled for durability, wear resistance. SAT (Spirig) Inc., 357 Cottage St, Springfield, MA 01104 (418) 788-6191 TWX-710-350-6466 Spirig P.O. Box 160 CH 8640 Rapperswil, Switzerland (055) 274403 Telex 875400

DUST TRAP MAT **226**

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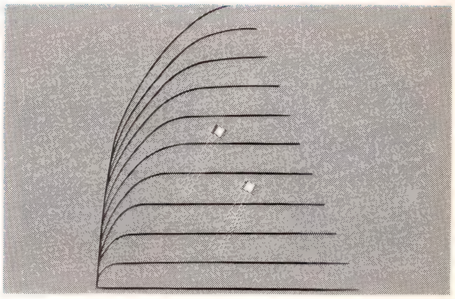
POWER SUPPLY CATALOGS **227**



700V, 1A NPN TRANSISTORS, the SPT 5502, have linear gain characteristics from 50mA to 1A, maximum delay times of 100 nsec and rise time fo 700 nsec. Gain-gand-width product is 10MHz. V_{EB} is 10V, I_C is 1A and I_B is 0.5A. $V_{CE(sat)}$ is 1V and $V_{BE(sat)}$ is 1.2V. Packaged in TO5s, operating temperature is −55°C to +200°C. Price: $12.50 each in 100 quantities. Delivery: stock. Solid State Devices, Inc., 14830 Valley View Avenue, La Mirada, CA 90638; (213) 921-9660; TXW 910-583-4907.

700V TRANSISTORS **228**

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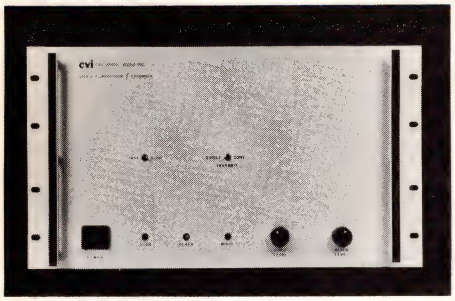
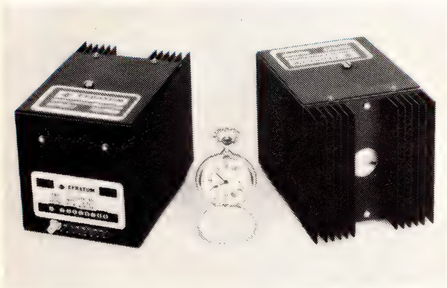


MODEL 280 VIDEO TRANSCEIVER. Model 280 Transceiver allows video teleconferencing over normal, dial-up telephone lines, and combines three functions: freezes a single frame of video; converts the picture for transmission over audio channels; receives and reconverts these signals to conventional TV standards. Sends 256 × 256 picture elements in 35 seconds; 256 × 512 in 74 seconds. Full specifications on request. Colorado Video, Box 928, Boulder CO 80306 USA; phone 303/444-3972.

VIDEO TRANSCEIVER 229

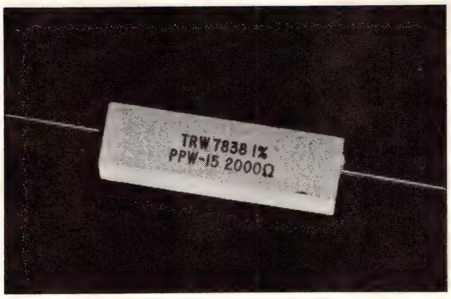
BT-2, a MAN-MACHINE interactive communication processor, provides VOICE output and TOUCH TONE (DTMF) input. It can be configured as a STAND-ALONE or FRONT-END to a host cpu. Based on DEC's LSI-11 processor the BT-2 comes with several telephone and computer interface options and software packages. PERCEPTION TECHNOLOGY CORPORATION, 95 Cross Street, Winchester, Massachusetts 01890, tel. (617)729-0110.

INTELLIGENT VOICE RESPONSE 231



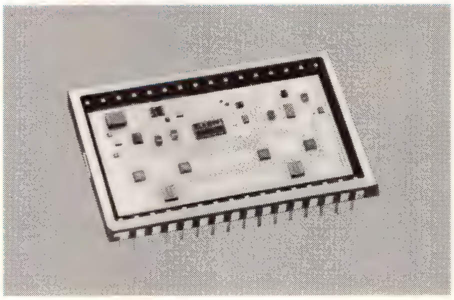
RUBIDIUM OSCILLATORS Series FRK are ultra stable, reliable, light (2.9 lb) small (4x4x4.5″) and ideal for navigation/position location and communication systems. The unit provides 10 MHz; 5 and 1 MHz optional. Long-term stability $1x10^{-11}$/month, short term $1x10^{-12}$/100 sec. avg times and extremely low noise. Available commercial and MIL (radiation hardened) EFRATOM CALIFORNIA, INC., 18851 Bardeen Ave., Irvine, CA 92715. (714) 752-2891

OSCILLATORS 232



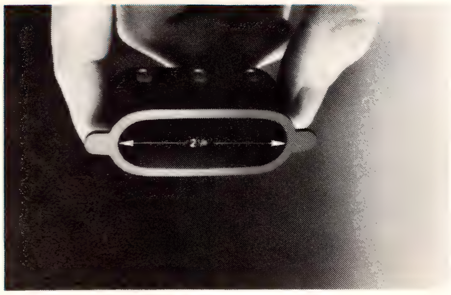
PPW SERIES FIREPROOF WIREWOUNDS from TRW are designed for pulse-loading and surge-discharge applications. Available in six power ratings from 2 to 15 watts. User can specify any resistance from 1 to 1600 ohms for 2-, 3- and 5-watt sizes, 1 to 2500 ohms for 7-watt size, 1 to 5000 ohms for 10- and 15-watt sizes. Standard tolerances are ±1%, ±2% and ±3%. Resistors made of alloy wire wound on ceramic core. TRW/IRC Resistors, an operation of TRW Electronic Components, 401 N. Broad St., Phila., PA. 19108. (215) 922-8900.

FIREPROOF WIREWOUNDS 233



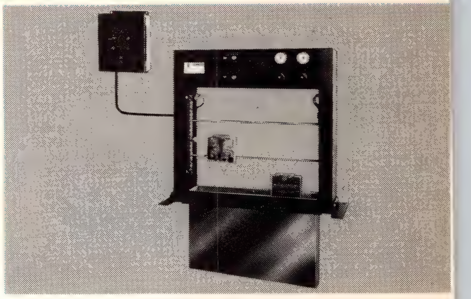
TINY LOW-COST 16 BIT A/D Space-saving A/D: ±0.003% linearity, 6 user-selectable input ranges, 100 μSec conversion time, internal clock, optional offset & gain adjustments, in 32 pin DIP, 1/4 the size of comparable modules. Uses less than 1.8 watts. Ideal for high resolution data acquisition systems, precision instrumentation, biomedical and other high accuracy applications. MN5280: $169./100's. Delivery: 4 weeks. Micro Networks Company, 324 Clark St., Worcester, MA 01606. Tel: (617) 852-5400.

TINY LOW-COST 16 BIT A/D 234



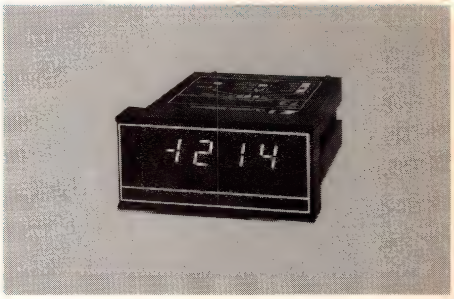
New "Big Boot" protects capacitors to 2-1/8″. Syntex now offers immediate delivery on production quantities of large-sized boots specially designed for today's larger capacitors. Also from Syntex: regular-sized capacitor boots, standard and custom-designed molded rubber and stamped parts. Fast service: one-day cost estimates; prototypes in three days. Call Ed Kirik, Jr. for details; (203) 367-8469. Syntex Rubber Corporation, P. O. Box 4006 (S-92), Bridgeport, CT 06607.

LARGE SIZE BOOTS 235



COAT YOUR OWN PRINTED CIRCUIT ASSEMBLIES. Put your own conformal coating of acrylic, polyurethane, epoxy, or whatever, on your printed circuit assemblies, with HumiSeal° Model 300 Dip Coating System. Our Model 300 is low in cost, but high in efficiency. It's a bench-top unit, extremely rugged, easy to operate, and meets requirements for use in hazardous locations. To find out all the other good things about it, write or call HUMISEAL° Division, Columbia Chase Corp., Woodside, NY 11377. (212) 932-0800. Cable: COLTECHNIC, New York.

DIP COATING SYSTEM 236



VERSATILE 3-1/2 DIGIT AC POWERED DPM Dynamic Sciences— announces the introduction of a versatile 3-1/2 digit AC powered digital panel meter (DPM). The meter is designed with an unusual degree of flexibility, allowing the user to meet a wide range of requirements in terms of voltage ranges and the necessary offsets needed to match transducer inputs to the DPM. It has an accuracy of 0.05% of a reading, plus or minus one digit over a 120-day period. DYNAMIC SCIENCES, 16150 Stagg St., Van Nuys, CA 91406. (213) 997-6414.

POWERED DPM 237

HOME COMPUTERS CAN MAKE YOU RICH, Joe Weisbecker. Provides a Wealth of down-to-earth money-making opportunities in the field of personal computing. For the home computer beginner or microcomputer expert, the book includes dozens of ideas potentially profitable for you. 5177-8, 128 pages, $5.95. **CIRCLE THE INFO RETRIEVAL NUMBER TO ORDER 15-DAY EXAM COPY.** When billed, remit or return book with no obligation. Hayden Book Co., 50 Essex St., Rochele Park, NJ 07662.

#HOME COMPUTERS

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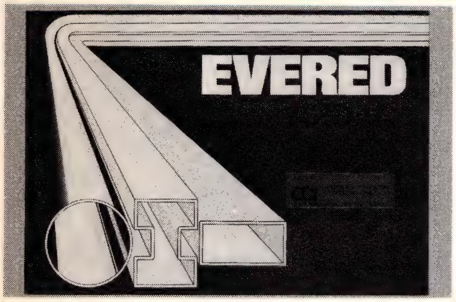
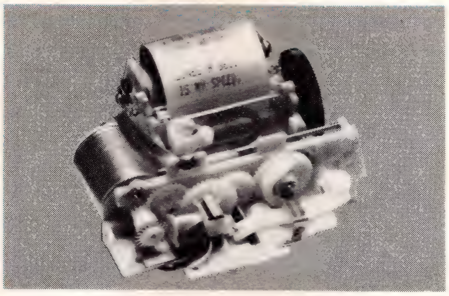


PRECISION DRAWN WAVEGUIDE Evered and Company (Metals) Limited has released their new technical data and catalog on high frequency transmission waveguide. The data contains information on operating ranges, dimensions, and materials available in both rectangular and circular waveguide. The catalog is available at no charge from their national distributor, Connolly & Company, Inc., 914 North Rengstorff Avenue, Mountain View, Ca. 94043, (415) 967-6988.

PRECISION DRAWN WAVEGUIDE 239



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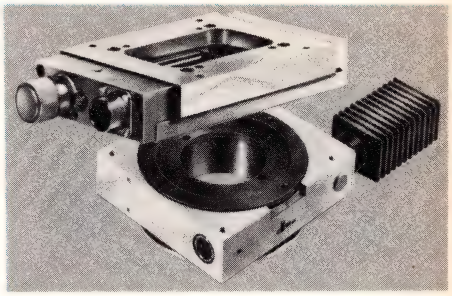

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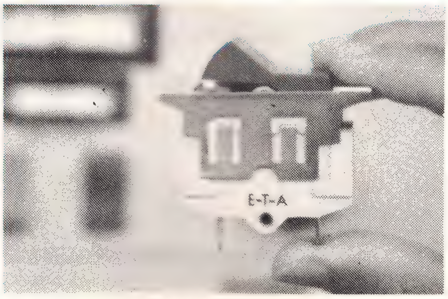

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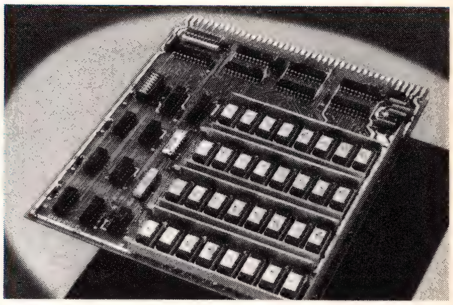

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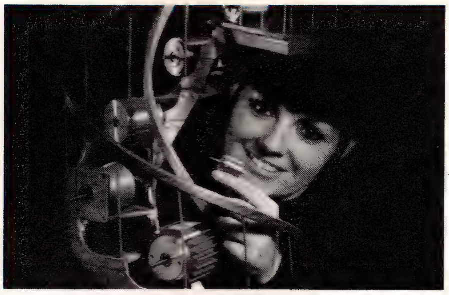

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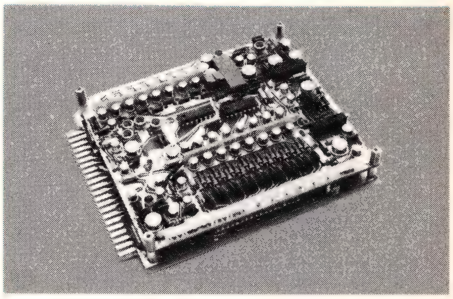

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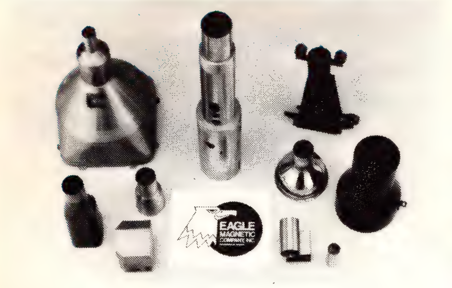

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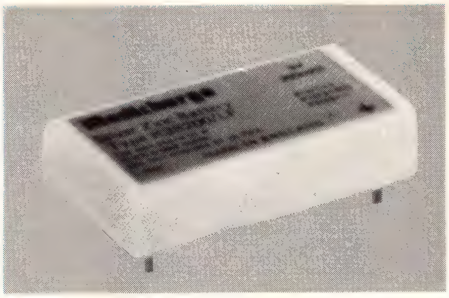

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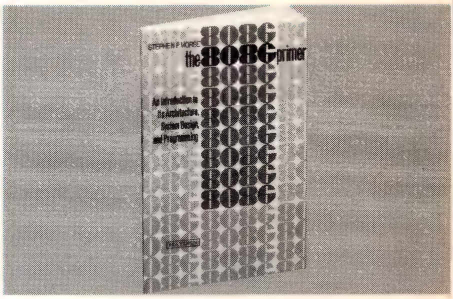
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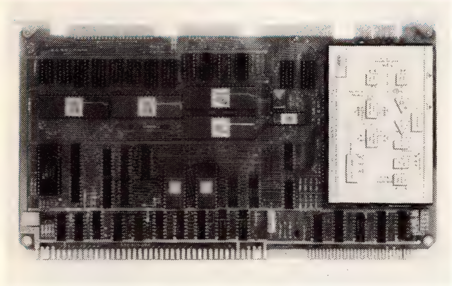

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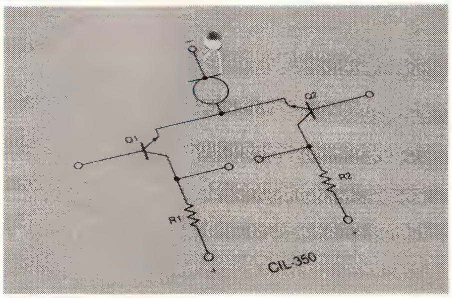

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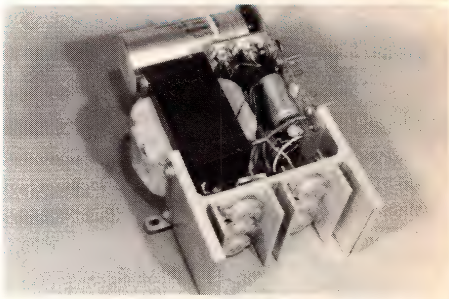

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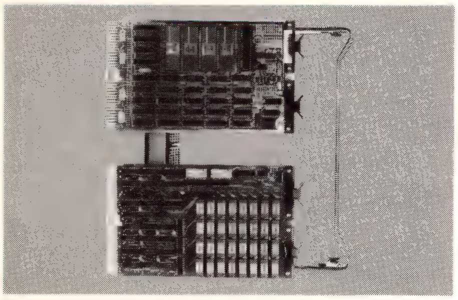

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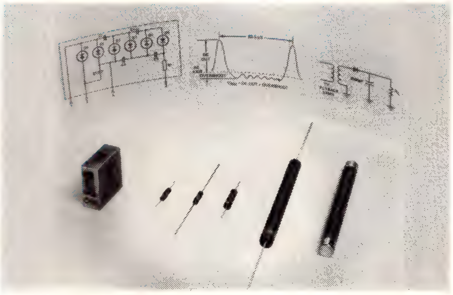

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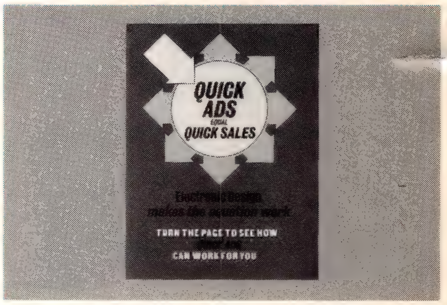

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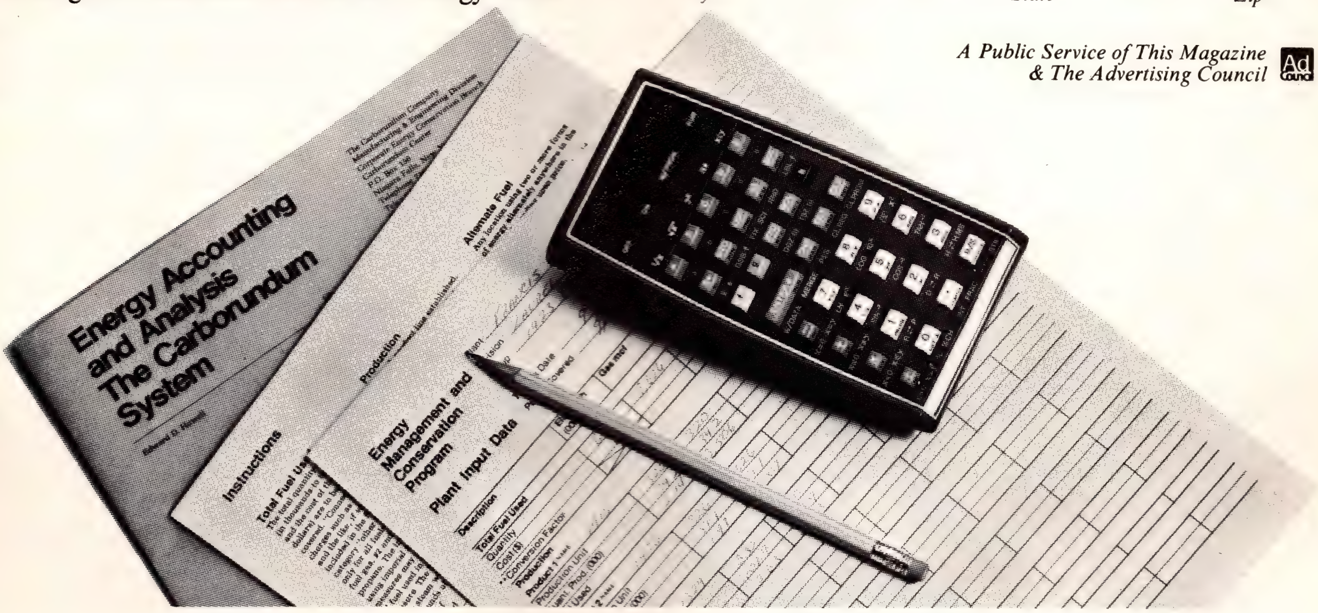
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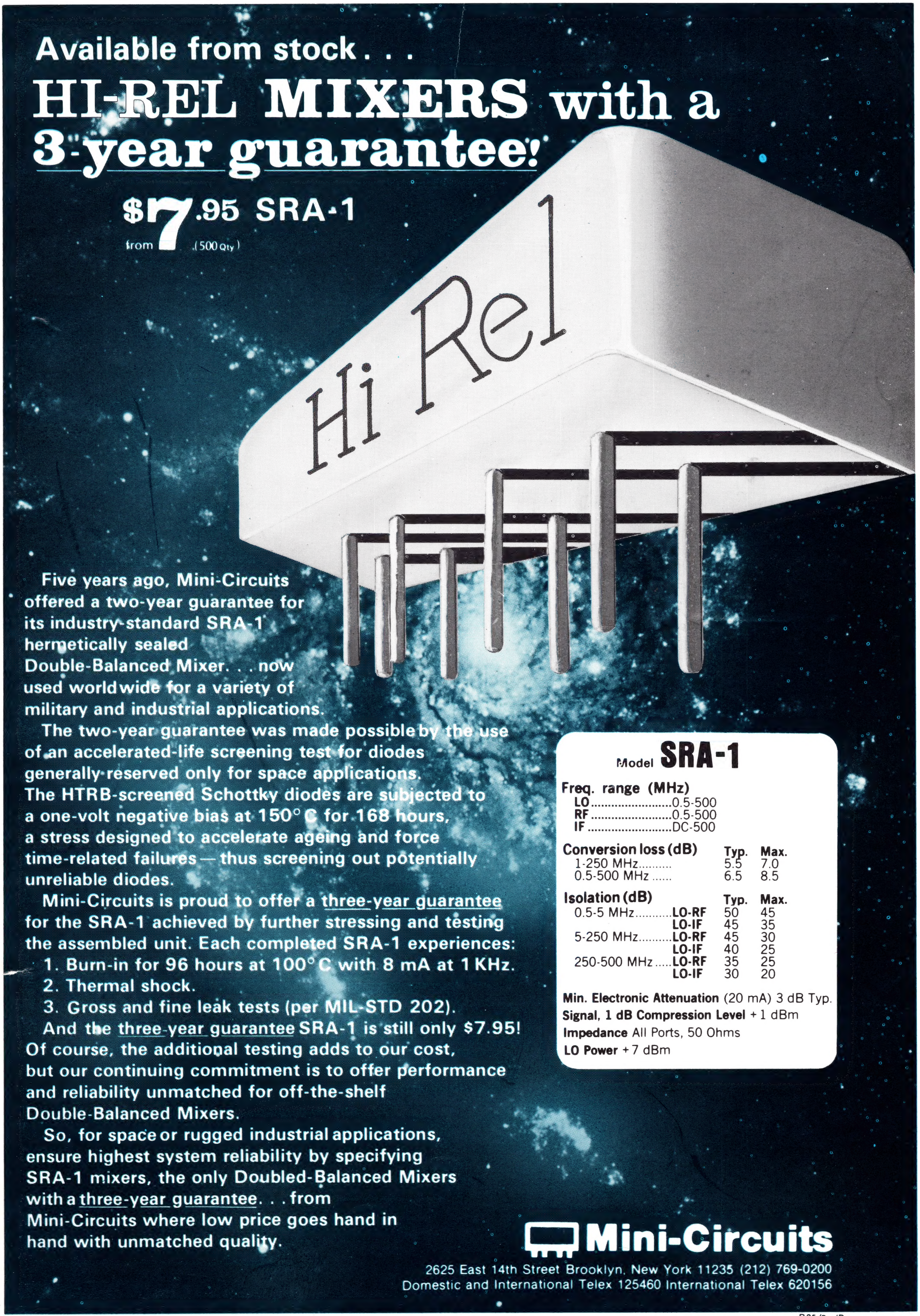

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Mini-Circuits is proud to offer a three-year guarantee for the SRA-1 achieved by further stressing and testing the assembled unit. Each completed SRA-1 experiences:

1. Burn-in for 96 hours at 100° C with 8 mA at 1 KHz.
2. Thermal shock.
3. Gross and fine leak tests (per MIL-STD 202).

And the three-year guarantee SRA-1 is still only $7.95! Of course, the additional testing adds to our cost, but our continuing commitment is to offer performance and reliability unmatched for off-the-shelf Double-Balanced Mixers.

So, for space or rugged industrial applications, ensure highest system reliability by specifying SRA-1 mixers, the only Doubled-Balanced Mixers with a three-year guarantee. . . from Mini-Circuits where low price goes hand in hand with unmatched quality.

Model **SRA-1**

Freq. range (MHz)
LO 0.5-500
RF 0.5-500
IF DC-500

Conversion loss (dB)		**Typ.**	**Max.**
1-250 MHz		5.5	7.0
0.5-500 MHz		6.5	8.5
Isolation (dB)		**Typ.**	**Max.**
0.5-5 MHz	**LO-RF**	50	45
	LO-IF	45	35
5-250 MHz	**LO-RF**	45	30
	LO-IF	40	25
250-500 MHz	**LO-RF**	35	25
	LO-IF	30	20

Min. Electronic Attenuation (20 mA) 3 dB Typ.
Signal, 1 dB Compression Level +1 dBm
Impedance All Ports, 50 Ohms
LO Power +7 dBm

Mini-Circuits
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Domestic and International Telex 125460 International Telex 620156

B35/Rev/B

Tested for Quality Time and Again...

Bourns Resistor Networks.

Put to the Test — From incoming inspection of the raw materials through final inspection prior to shipment, Bourns DIP and SIP resistor networks are stringently tested to assure the highest quality possible.

First article inspection is performed at every key manufacturing step. All parts are laser-trimmed to their correct value and then 100% inspected. Rejects are sorted out, eliminating many latent defects. Only parts passing inspection are assembled and then subjected to an additional 100% parametric test. This electrical test is followed by another QC inspection prior to shipment.

Designed In Quality — Inside and out, Bourns resistor networks are designed to deliver superior performance and trouble-free operation. Inside, the Bourns exclusive KRIMP-JOINT™ lead frame termination design provides both a mechanical and electrical bond that assures reliability. Outside, a proprietary molding technique eliminates the mold gate, resulting in a dimensionally stable, thermoset plastic package.

Auto-Insertion — Inserting molded Bourns DIP and SIP resistor networks is the same as inserting ICs. No changing of adjustments is necessary on the automatic insertion equipment.

Superior Performance — Bourns resistor networks offer superior load life, better thermal shock performance and lower, more uniform tempco.

Verified quality, competitive pricing, distributor availability, a broad line of both DIPs and SIPs, and excellent delivery. Put Bourns Resistor Networks to the test. Call or write today for your new catalog. Or, see the EEM directory (Volume 2, pages 3639 - 3645).

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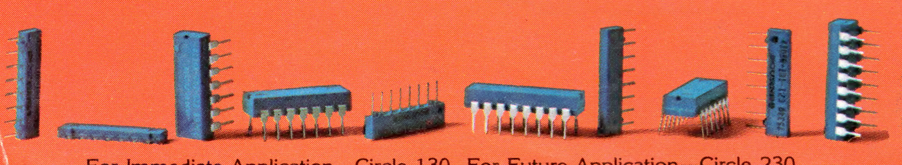

BOURNS®

For Immediate Application—Circle 130 For Future Application—Circle 230